UTH GRAND-OSAGE
VER BASIN IN
MISSOURI

U. S. DEPARTMENT OF AGRICULTURE REPORT

Prepared by

STATE OF MISSOURI

FOREST SERVICE

SOIL CONSERVATION SERVICE

ECONOMIC RESEARCH SERVICE

1970

ECONOMIC RESEARCH SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

FIELD ADVISORY COMMITTEE, SOUTH GRAND-OSAGE RIVER BASIN
Columbia, Missouri 65201

July 1, 1970

The Honorable Warren E. Hearnes
Governor of Missouri
Jefferson City, Missouri

Dear Governor Hearnes:

The attached United States Department of Agriculture report presents information regarding opportunities for water and related land resource development in the South Grand-Osage River Basin. The Department of Agriculture participated in this cooperative survey with the State of Missouri in response to a request from the Office of the Governor, dated November 12, 1962.

The Department of Agriculture's participation in the survey is authorized in the provisions of Section 6, Public Law 566, 83rd Congress, as amended. This authorization permits the Department to cooperate with other federal, state, and local agencies in making investigations and surveys of watersheds within a river basin as a basis for development of coordinated programs.

The survey presents information obtained from cooperative investigations by the Economic Research Service, Forest Service, and Soil Conservation Service of the Department of Agriculture and by the State of Missouri.

This report of an investigation and survey completes the assignment of the Department of Agriculture as provided in the plan of work for the South Grand-Osage River Basin study.

Sincerely yours,

J. Vernon Martin

J. Vernon Martin
State Conservationist
Soil Conservation Service
and
Chairman, USDA Field
Advisory Committee

REPORT ON
THE WATER AND RELATED LAND RESOURCES
SOUTH GRAND - OSAGE RIVER BASIN
MISSOURI

Photo by: Walker-Missouri Tourism

Flowering dogwood in the Ozarks

Prepared By

U. S. DEPARTMENT OF AGRICULTURE

Economic Research Service
Forest Service
Soil Conservation Service

STATE OF MISSOURI

Water Resources Board

July 1970

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SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI

SUMMARY

This report by the U. S. Department of Agriculture is a portion of a comprehensive plan for development of the water and related land resources in the South Grand-Osage River Basin. The study was made under authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). The State of Missouri participated through the Missouri Water Resources Board and other resource-oriented agencies.

Objective and Scope of the Study

The objective of this study is to formulate a plan for the cooperative and orderly conservation, development, utilization and management of the water and related land resources in the Basin. When implemented, the plan will help promote local economic growth.

Studies were made to determine present and future land use, agricultural output, yields, and employment. Population projections were made and related to the development of water and related land resources for production of food and fiber; rural, municipal and industrial water supply; and water-oriented recreation. Upstream water and related land resource problems were identified, and the need for water resource development was appraised.

An inventory and analysis was made of present and potential water and related land resource development and management in upstream watersheds. The measures investigated included proper land use and treatment of land resources; structural measures such as dams and channel improvement for drainage and to reduce floodwater and sediment damages; and the storage of water for irrigation, recreation, fish and wildlife, rural water supply, municipal and industrial water supply, and water quality control purposes.

The USDA programs and projects that can meet the present and projected needs for water and related land resource development were identified and appraised. Early-action and long-range projects were analyzed. This report includes projections based on expected population growth and economic development for the years 1980, 2000, and 2020.

Resources of the Basin

The South Grand-Osage River Basin, comprising 10,750 square miles in West-Central Missouri, is a part of the Osage River Basin drainage system of 15,300 square miles originating in Kansas. This area includes all of nine and parts of eighteen counties.

Its climate is essentially continental, with average precipitation from 36 to 42 inches and average annual runoff from 8 to 11 inches.

Two major Land Resource Areas represent most of the Basin; the western 37 percent is Cherokee Prairies Area, and the eastern 63 percent is Ozark Highland. The Cherokee Prairies Area is nearly level to gently sloping with wide flat stream valleys. Soils are derived from Pennsylvanian sandstones and shales and have a silty loess mantle. The Ozark Highland is characterized by its steep slopes, narrow ridges and valleys, and stony soils derived from Mississippian and Ordovician limestone, dolomite and chert. Scenic hills and spring-fed streams are natural features.

Land available for agriculture and forestry comprises 6,363,600 acres; 36 percent in cropland, 24 percent in pasture, 36 percent in forest, and 4 percent other. Over 99 percent of the land is in private ownership, and 61 percent of the farms are commercial. An average-size farm in 1964 was 220 acres, while average investment in land and buildings was $123 per acre. Gross value of crops and livestock was $195.4 million.

Forest land amounts to 2.3 million acres of which 96 percent is classified as commercial forest land. The timber growing stock is increasing 5.4 percent annually or 28.6 million cubic feet. The annual cut is estimated at about 34 percent of the growth. Forty-four sawmills, 17 charcoal plants, and five stave mills make up the bulk of the wood-using industries which employ 1,650 people.

Three State Parks, Lake of the Ozarks, Bennett Springs, and Pomme de Terre, had over 1.6 million visitors in 1968. Kaysinger Bluff and Stockton, Corps of Engineers' Reservoirs still under construction, are expected to accommodate 3.5 million visitors annually. Private development around existing lakes is expanding rapidly.

Population reached a peak about the turn of the century, but it has been declining. About 253,300 people lived in the Basin in 1960; 30 percent was classified rural farm and the remainder about equally divided between rural nonfarm and urban. Lack of employment opportunities for the younger people has caused an out-migration of the under-45 age group from rural areas. An in-migration of retired and semi-retired people is taking place in the proximity of the large reservoirs.

Employment was nearly 88,000 in 1960. This constitutes about 35 percent of the population. Agriculture employs 25 percent of the work force. About 16 percent are employed in mining, forestry, and manufacturing; and the remainder in construction, transportation and service industries. In 1959, all counties had median family incomes below the average of $5,127 for Missouri and $5,660 for the United States. Per capita income was $1,290 in 1959.

Problems and Needs

The most important need is to create an atmosphere of stability and provide opportunities through resource development for the Basin's most vital resource--its people. Employment and increased income are needed to curb the out-migration of the work force. Multiple use of resource developments is

needed to maintain the growth of both rural and urban communities and provide sustained employment for the people. Better utilization of the land resources is needed to stabilize agricultural income and production.

Most damage to crop and pasture lands is from sheet and rill erosion. Soils subject to erosion hazard constitutes 68 percent of the crop and pasture lands. Sediment resulting from this erosion deteriorates water quality and restricts channel capacity. Erosion control measures are needed on 1.8 million acres of crop and pasture land. One million acres of cropland need mechanical practices, such as: terraces, diversions, contour farming, and stripcropping. Nearly one and a quarter million acres of pasture need conservation treatment. Improved drainage would increase the efficiency on 91,070 acres of cropland. An additional 184,660 acres of upland, claypan soils have a need for practices to control erosion and correct inherent drainage problems.

Forestry treatment needs include: tree planting--588,000 acres; stand improvement--1,339,500 acres; erosion control on log roads and skid trails--11,980 acres; and management plans--1,677,700 acres. Approximately 1,089,700 acres of forest land need fencing to exclude livestock. An additional 410,300 acres, although fenced, is being grazed and should be protected. The cumulative, forest, land treatment needs total 4,706,880 acres of measures on 1,677,700 acres of land.

Major floodwater damage occurs on 371,900 acres of bottomland, 256,600 acres of which are in tributary watersheds. Flooding reduces crop and pasture production and damages roads, bridges, fences, recreation enterprises, and limited urban areas. Current annual damages are estimated at over 2.6 millio-dollars and are expected to exceed 3.5 million dollars by 1980. Land treatment, temporary reservoir storage and/or channel improvement are needed to reduce these damages.

Drought periods lasting three weeks and longer occur an average of once per year in July or August. These periods result in reduced yields on crops and pastures and cause water shortages for rural domestic and livestock water supply.

In the western part of the Basin, low quality ground water results in curtailed domestic use even under normal conditions. Organization of rural water districts is needed to improve the quality and safety of rural water supplies. Additional water needs in 1980, above present supplies are: 4,185,000 gallons per day for domestic purposes; 11,361,400 gallons per day for municipal and industrial use; and 4,016,000 gallons per day for livestock. A quality water supply is needed for domestic use, industrial expansion, and the recreational needs of the people.

Except for small lakes and strip pits, available recreational waters are located from 75 to 200 miles from metropolitan Kansas City. A shortage exists for recreational reservoirs within day use travel distance of this population center. Recreational needs include the total for the Basin and the Kansas City and Springfield SMSA's. These needs will require 1.7 million recreation days by 1980; 2.7 million by 2000; and 3.2 million by 2020.

The quality of the Basin's environment needs improvement and protection. Tilling of marginal lands, strip mining, improper forest land management, clearing of lands having high flood hazard or steep slopes, ill advised drainage, and channel straightening have not only affected hydrology but have left unsightly scars on the landscape. Past attempts to manage water have provided a solution to localized or individual problems without full consideration of the effects on the hydrology of the Basin or the aesthetic and ecological environs associated with water and land use.

Findings and Conclusions

The 199 impoundment sites investigated for flood retarding structures are only part of the total potential in the Basin. Additional sites are available primarily in LRA 116. Most sites investigated have a potential for multipurpose storage. Sites of smaller size are generally available and could provide storage needs for single purpose uses or alternates for multiple purpose sites.

A potential exists for providing protection from flooding and to increase crop production efficiency by using channel improvement and levees in addition to floodwater retarding structures. Bottomland not feasible to protect from flooding has a potential for forest crops under intensive management.

In the eastern two-thirds of the Basin, the large supply of high quality ground water is an outstanding asset for development. The remainder of the Basin has much less potential because the water is highly mineralized and yields are generally lower.

Although irrigation is marginal in most situations, it is expected to be practiced more in the future. Almost three million acres of land is suitable for supplemental irrigation. Over half of this land could be provided water from surface sources at a 50 percent depletion of average annual runoff.

Much of the Basin is endowed with natural resources that appeal to the aesthetic wants of the people. A potential exists for providing additional water and land for recreational purposes. Reservoirs can be located to provide people with access to high quality recreational developments within a reasonable driving distance for day use. Recreation enterprises on privately owned farms also have a potential for development.

Providing additional public access to reservoirs and the construction of small reservoirs near population centers have potential for increasing the fishing opportunities. Fish and wildlife purposes could be better served by maintaining minimum stream flow through water releases from reservoirs, planned access, elimination of water pollution, and reduction of sediment. Hunting opportunities could be improved by landowners granting public access and the conversion of land into wildlife areas. The greatest opportunity for improving surface water quality is through the control of pollutants at their source.

A potential for land treatment exists on 63 percent of the cropland, 82 percent of the pasture, and 75 percent of the forest. The full resource development and utilization of the Basin would require the application of land

treatment on 1,444,000 acres of cropland, 1,225,400 acres of pasture, and 4,706,800 acres of land treatment measures on 1,677,000 acres of forest land. The formation of nine Soil and Water Conservation Districts would provide additional technical assistance for applying conservation measures.

Application of conservation measures through accelerated programs with individual landowners and the control of sediment and runoff through group action can contribute to the improvement of the environment. Reclamation or conversion of land to its most beneficial use will not only establish a balance between the economic and aesthetic, or environmental resource contributions, but will serve to retain its unique characteristics.

Opportunities for watershed development through the Public Law 566, Small Watershed Program fall into two major categories--land treatment and structural measures. Twenty-eight percent of the land base has been adequately treated. Considering the present rate of accomplishment under the "going" program of the Soil and Water Conservation Districts plus an accelerated rate because of technical assistance available to early-action watersheds, 53 percent of the cropland and 35 percent of the pasture will be adequately treated by the year 2000.

Approximately 265,870 acres of land treatment measures will be installed on forest land by year 2000 under going programs. This includes 14,220 acres in potential P.L. 566 watersheds, 202,500 acres on forest land above existing or proposed structures other than P.L. 566, and 49,150 acres remaining Basin forest land.

The combined going and accelerated programs would result in 48 percent of the land base or 467,380 acres receiving land treatment by year 2000. Technical assistance required for the going programs is $3,070,300 and the accelerated programs $14,544,700. Land treatment installation would cost an additional $39,998,000.

Sixteen watersheds were determined to be feasible projects for early-action development and can start in the next 10 to 15 years. These projects provide opportunities to develop the water and land resources and to improve employment and income in accordance with the Basin needs. Included in the projects are land treatment, flood prevention, water supply, and recreation and/or fish and wildlife. They are economically feasible under current criteria. Twenty long-range projects may require project action during the next 50 years.

Three proposed USDA projects are considered first alternates for structure sites investigated by the Corps of Engineers--Butler, East Branch, and Nevada Reservoirs. Freeman Reservoir was considered first alternate for three USDA sites in the Upper South Grand River Watershed.

Early-action projects provide an opportunity to reduce floodwater damages on 117,910 acres of bottomland with 98 structures and 69.5 miles of channel improvement. Sixty-four structures are single purpose flood prevention, and 34 have multiple purpose storage. The storage in 16 structures will provide 31,850 acre-feet of water for municipal and industrial use of 22 towns having a projected population of 72,900 by year 2020. Recreation and/or fish

and wildlife is included in 26 structures. The full development of public recreational areas would provide 9,308 acres of water and would require 23,950 acres of land for facilities. This will meet the total projected needs of the Basin and the Kansas City and Springfield SMSA's. However, developments in other basins are expected to fill a portion of the SMSA's needs. Full potential development of the structure sites could provide 225,200 acre-feet of additional storage which would be available at additional cost to non-federal interests.

The total first cost of structures in the early-action projects is $49,852,160. Of this, Public Law 566 costs are estimated to be $25,987,850 and other costs $23,864,310. Annual cost, including operation and maintenance, is $3,277,420, and annual benefits are $5,877,660. Annual costs and benefits, based on a 4 7/8 percent interest rate, were amortized for 100 years.

Average annual damage reduction benefits on 117,910 acres of flood plain were estimated at slightly over one million dollars. In addition, nearly $650,000 in increased net returns is expected from better utilization of flood plain land.

Recreation benefits will exceed $3.7 million annually. Redevelopment and secondary benefits are expected to increase the annual benefit of the projects by $749,200.

Irrigation development will primarily benefit the individual farmer by providing a more stable production and income. Surface field drains provide about two-thirds of the drainage benefits. About one-fourth of the total drainage needs will be met by year 2000.

An expected increase in upland conservation measures will be beneficial to wildlife, while more intensive use of bottomland will have an adverse effect. Channel improvement will have a detrimental effect on stream fisheries, but 14,060 surface acres in permanent pools will increase the lake fisheries. Mitigation measures should be incorporated as part of the project, when fish and wildlife habitat is destroyed.

The land base for agriculture will be reduced by 58,760 acres for the proposed USDA early-action projects. Projected land base is expected to be reduced 213,000 acres by year 2000.

The projected requirements for agricultural production can be met with resource development at an estimated savings of $489,000 in production costs. This savings is a measure of national efficiency gains or national benefits.

U. S. DEPARTMENT OF AGRICULTURE

SOUTH GRAND-OSAGE RIVER BASIN

MISSOURI

I. INTRODUCTION

This report presents the results from the study and analysis of the physical and economic potential for the development of water and related land resources in the South Grand-Osage River Basin. The goals of the State of Missouri, recognized problems, and present and future needs are the basis of this study. These and other salient points are discussed in this section.

A. Description

The South Grand-Osage River Basin, comprising approximately 10,750 square miles in West-Central Missouri, is a part of the Osage River Basin consisting of a drainage system of 15,300 square miles and originating in Kansas. In the River Basin Atlas, Principal Land Resource Areas are 112 - Cherokee Prairies, and 116 - Ozark Highland.

The population of about 253,000 is generally rural in nature. The largest town, Nevada, had a population of 8,500 in 1960. Springfield, on the south boundary, has a population of 96,000. The Kansas City metropolitan area, just outside the Basin, has a population of 1,040,450.

Agriculture, the most important economic activity, forms the base for related industries. About 60 percent of the farms are classed as commercial farms, and the remainder are part-time or part-retirement farms. One-half of the operators work off their farms. Forest products, forest-based employment, and the value of forest recreational activity contribute to the economy. Surface coal mining is another activity of economic importance. Most of the coal is used locally for generation of electricity.

Recreation and tourism are economically important to the area. The Lake of the Ozarks is recognized as a national and regional recreation center. The more recently developed Pomme de Terre Reservoir provides additional recreational possibilities. When completed, Stockton and Kaysinger Bluff Reservoirs will have 80,500 acres of water available for recreation.

B. Authority

The study was made under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended). The Secretary of Agriculture is authorized to cooperate with other Federal, State, and local agencies in their investigations of watersheds, rivers, and other waterways to develop coordinated programs.

C. Needs and Objectives

The South Grand-Osage River Basin is subject to high intensity rainstorms, resulting in severe sheet erosion on unprotected soils and sedimentation. Long-term stream gage records indicate that most of the major streams and tributaries average one or more damaging floods per year.

Water management needs include: the reduction of flooding and sediment damages; the provision of storage for domestic, industrial, and agricultural uses; and the development of water and related land for recreational purposes. Other needs include drainage on agricultural lands and adequate quantity and quality of water supply for municipal and rural communities.

Kaysinger Bluff Reservoir, a major impoundment, currently under construction by the Corps of Engineers, will reduce flood damages and silting in the Lake of the Ozarks and flood damages on the main stem below Bagnell Dam. However, the water and related land problems in the tributary areas above Kaysinger remain unsolved. The Governor of Missouri, in his request for assistance, stated:

> "Since it (Kaysinger) is the first of the proposed projects in the State to be located in agricultural areas, it is very desirable, not only in the economy of a very considerable part of our State, but also in the national interest, that an investigation and survey of the watershed above this impoundment be made as a basis for the development of coordinated programs in water control....
>
> The area has great possibilities for providing the recreation so important to our urban people and for providing a better living to the people of the area as the capacity of the land to provide both agricultural products and recreational services is developed."

The State of Missouri seeks the following goals through application of programs for conservation, development, management and use of the water and related land resources of the State:

1. Development and management to assure a supply adequate to meet seasonal long-range requirements for domestic, municipal, industrial, agricultural, fish and wildlife, recreation, power, navigation, and quality control purposes from surface or ground water sources or from a combination of the two.

2. Contribution to the establishment, diversification, and stabilization of a local economic base having capability to sustain acceptable living standards within the community and providing sufficient employment opportunities to dampen out migration.

3. Implementation of land use practices that effectively reduce siltation and loss of the land base through irresponsible practices associated with farming, mining, construction, forestry, and other control actions of man.

4. Improvement of water quality through control of municipal and industrial waste discharge, agricultural pollution, acid mine drainage, and littering to permit and encourage additional use of the available water supply at any location and at any period of time.

5. Maintenance of an environment that offers a diversity of recreational and aesthetic experience in keeping with the regional or local resource capability.

6. Retention of those basic features which contribute to the historic uniqueness and character of the State and its several regions.

7. Application of the multiple use concept to water and related land resources in a manner that will permit utilization of the resource base in an efficient and balanced manner to serve the greatest number of people.

The objectives of this study and report are to formulate a plan for the cooperative and orderly conservation, development, utilization and management of the water and related land resources in the Basin.

An evaluation was made to determine the importance of agriculture and related economic activities to the Basin, the State of Missouri, and the Nation. This provided a basis to estimate the need for and value of potential water and land resource developments. Activities analyzed and projected include land use, output of agricultural products, expected yields under assumed levels of technology and management, agricultural employment, and expected shifts of agricultural land to other uses. Projections of the needs to develop water and related land resources for food and fiber production, rural, domestic and municipal water supply, and water-oriented recreation were made.

Water and related land resource developments required to meet short and long-range needs were identified. The plan includes the identification and evaluation of potential projects which should be initiated during the next 10 to 15-year period. Special attention is given to those project proposals which can be carried out under the legislative authority of Public Law 566 during this period.

D. Participants

The U. S. Department of Agriculture's participation was in accordance with the Memorandum of Understanding among the Economic Research Service, Forest Service, and Soil Conservation Service dated February 2, 1956, and revised April 15, 1968.

The State of Missouri participated in this study through the Missouri Water Resources Board which coordinated State agency contributions.

E. Investigations and Use

Existing information from reports of previous studies, as well as available information from various Federal, State, and private sources, was used to the extent it was suitable. This includes current Conservation Needs Inventory and preliminary Missouri River Basin Type I study data.

Information regarding water resource development needs from the Missouri River Basin Type I study, as well as information from map and photo studies and field reconnaissance, was used in identifying those watersheds with a potential for development.

These watersheds were studied in sufficient detail to identify the intensity and extent of flooding and water management problems. Flood plain information on soils, land use, and crop yields was collected in the field. Valley cross-sections for flood routing purposes were surveyed in each watershed which indicated a short-range development potential.

The information gathered was used in the hydrology and economic computer programs to evaluate damages and benefits. Full use was made of aerial photographs and topographic and other maps in the inventory of potential structure sites. Structure sites proposed in the 10 to 15-year plan were checked by field reconnaissance.

Forest resource statistical data and related information were compiled from forest survey data developed by the North Central Forest Experiment Station for the State of Missouri and the Missouri River Basin Comprehensive Type I Study.

Information regarding population, income, employment, agricultural production, and present and projected use of water and related land resources for the years 1980, 2000, and 2020 was refined from data developed for the Missouri River Basin Comprehensive Type I Study. All monetary references are based on dollar values that do not reflect inflationary trends.

The results of this study will be used by the Water Resources Board in the formulation of the South Grand-Osage River Basin portion of the State water plan.

The survey will assist the Department of Agriculture in making the most effective use of their limited resources in the administration of the PL-566 watershed program. It will serve also as a guide in coordinating related water and land resource development programs and projects of other local, Federal, and State agencies.

F. Acknowledgments

Cooperation, data, and assistance for this U. S. Department of Agriculture Report were provided by the following local, State, and Federal agencies:

U. S. Agricultural Stabilization and Conservation Service
U. S. Army Corps of Engineers, Kansas City District
U. S. Bureau of Census

U. S. Bureau of Mines
U. S. Bureau of Outdoor Recreation
U. S. Fish and Wildlife Service
U. S. Geological Survey, Surface Water Branch
Federal Water Pollution Control Administration
Missouri Commerce and Industrial Development
Missouri Department of Conservation
Missouri Division of Health
Missouri Geological Survey and Water Resources
Missouri Park Board
Missouri Soil and Water Conservation Commission
Missouri Soil and Water Conservation Districts
Missouri State Highway Department
Missouri Water Pollution Board
University of Missouri
University of Missouri Extension Service

II. PHYSICAL RESOURCES OF THE BASIN

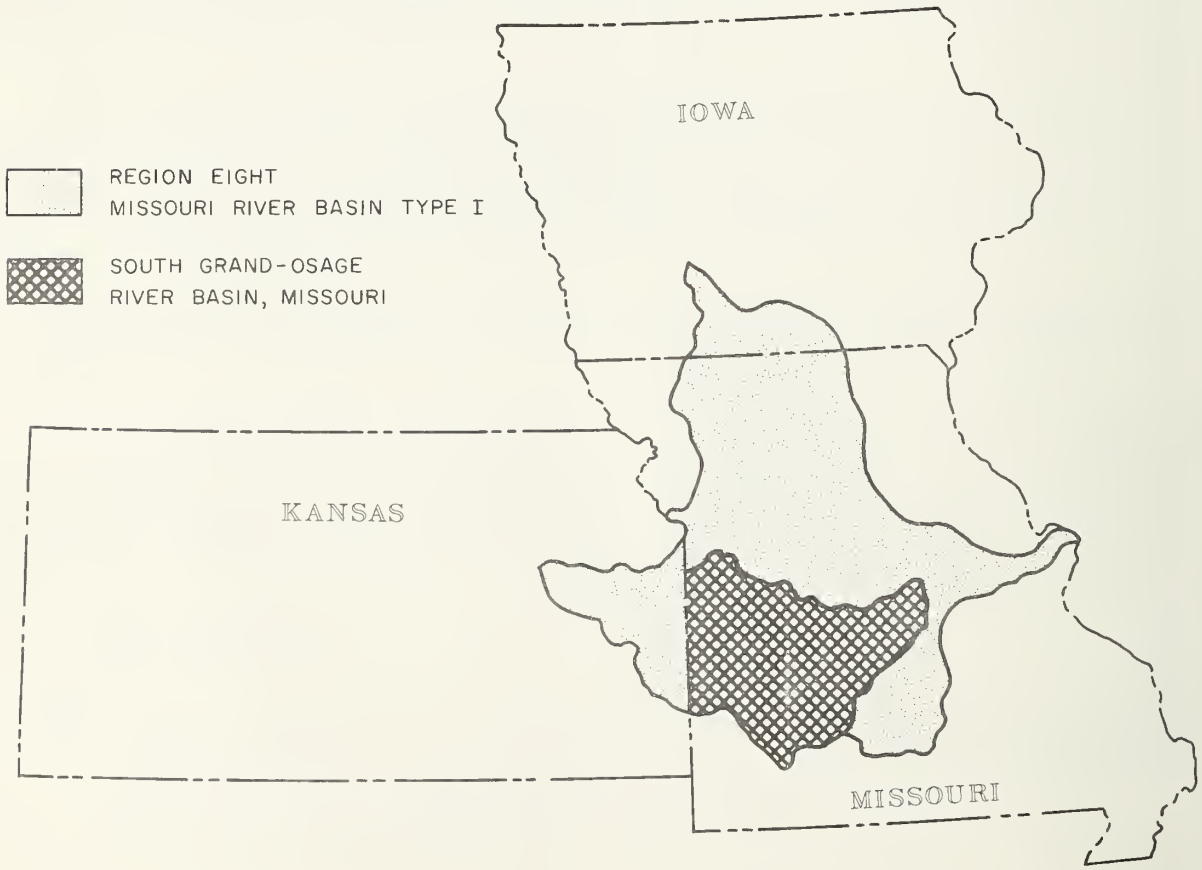
Basic to the potential for development of water and related resource development is the endowment of physical resources. The soils, geology, physiography, climate, land use, water quality and quantity and natural environment are factors which must be considered in planning resource development. Each is important and makes its unique contribution to the physical capacity and potential development of the Basin. This chapter describes and inventories these resources.

A. Description

The South Grand-Osage River Basin study area is that portion of the Osage River Basin located in Missouri (Map 1). The Osage River is a south tributary of the Lower Missouri River.

The Marais des Cygnes and Little Osage Rivers originate in Kansas and join near the Missouri-Kansas border to form the Osage River which flows northeastward to join the Missouri River 12 miles east of Jefferson City. It is the largest tributary entering the Missouri River in the state. The major tributaries are: Little Osage, Niangua, Pomme de Terre, Sac, and South Grand Rivers.

MAP I: LOCATION MAP
SOUTH GRAND-RIVER BASIN, MISSOURI



All of nine and parts of eighteen additional counties are in its drainage area of approximately 6,881,355 acres (Table 1).

Table 1. Total Area and Percent Within the Basin: South Grand-Osage River Basin, Missouri

County	Area in Basin Acres	Percent	County	Area in Basin Acres	Percent
Bates	538,880	100	Morgan	179,360	46
Camden	452,480	100	Maries	148,150	44
Cedar	317,440	100	Barton	162,560	43
Dallas	343,680	100	Laclede	195,890	40
Henry	471,680	100	Osage	126,340	32
Hickory	262,400	100	Cole	81,130	32
Polk	410,880	100	Webster	104,345	27
St. Clair	448,000	100	Lawrence	92,800	23
Vernon	536,960	100	Johnson	99,900	19
Cass	433,420	97	Pulaski	57,500	16
Miller	352,920	91	Jackson	35,820	9
Dade	286,720	89	Christian	10,240	3
Benton	430,210	89	Pettis	5,330	1
Greene	296,320	68	TOTAL	6,881,355	

Kansas City metropolitan area and Jefferson City, the Missouri Capital, lie immediately outside the Basin to the northwest and northeast, respectively. Springfield, the third largest city in Missouri, is located in the south-central area near the southern border.

B. Climate

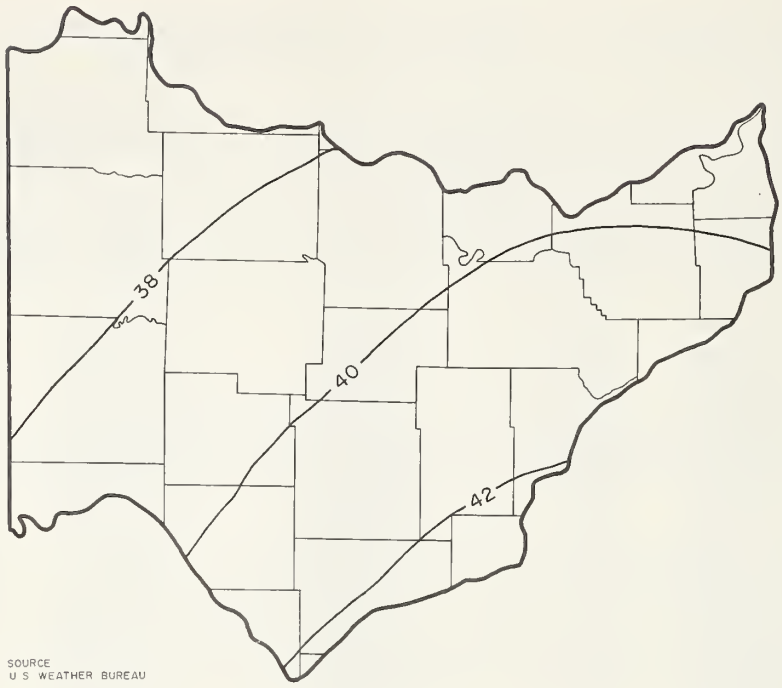
The climate is essentially continental with frequent changes in the weather occurring, both from day to day and from season to season. It is in the path of cold air moving out of Canada; warm, moist air coming out of the Gulf of Mexico; and dry air coming from the west.

Annual precipitation averages from 36 to 42 inches but varies appreciably from year to year (Map 2). For instance, precipitation extremes of 23 inches and 60 inches were recorded at Clinton. Most of the precipitation comes in the spring and summer in the form of showers and thunderstorms. Thunderstorms and heavy rains are most frequent from April through July. Measurable precipitation occurs on an average of 100 days a year with one-half from thunderstorms.

In the summer, temperatures rise to 90 degrees Fahrenheit or above for an average of 45 days. Temperatures below 32 degrees Fahrenheit occur, on the average, about 100 days per year. Temperatures over 100 degrees and subzero temperatures occur infrequently.

MAP 2: NORMAL ANNUAL PRECIPITATION IN INCHES

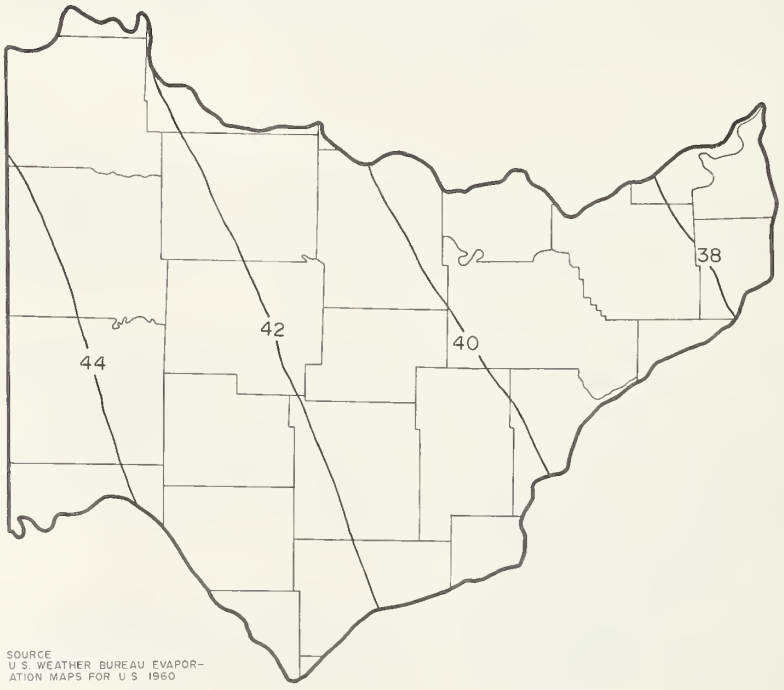
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



SOURCE
U S WEATHER BUREAU

MAP 3: AVERAGE ANNUAL LAKE EVAPORATION IN INCHES

SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



SOURCE
U.S. WEATHER BUREAU EVAPOR-
ATION MAPS FOR U.S. 1960

The average growing season is 185 days. The date of the last light freeze in the spring occurs in mid-April, and the first freeze in the fall around the third week of October. In the higher elevations of the Ozarks, freezes are two weeks later in the spring and one week earlier in the fall.

Prevailing winds are from the south-southwest and average between 10 to 12 miles per hour. Maximum velocities have exceeded 70 miles per hour. The hot, southwesterly, dry winds often occur during the growing season and are detrimental to crops. The average annual lake evaporation varies from 37 to 45 inches (Map 3).

C. Physiography and Geology

The Basin area lies in the eastern portion of the Western Plains physiographic province and the northwestern portion of the Ozark physiographic province of Missouri. The bedrock is represented from west to east by the Pennsylvanian System from the Kansas City Group down through the Pleasanton, Marmaton, and the Cherokee-Krebs subgroup. Underlying the Pennsylvanian System is the Mississippian System represented by the Maramecian and Osagean Series. The Mississippian escarpment in western Benton and Hickory Counties represents the contact between the Mississippian and Ordovician System. The Ordovician System is represented by the Canadian Series. The strata of the Canadian Series is comprised of massive dolomites represented by the Cotter-Jefferson City, Roubidoux and Gasconade Formations.

The Basin can be divided into seven regions based on the geology and general soil characteristics (Map 4). Areas I, II, III, and IV are influenced regionally by the Forest City Basin and the general bedrock dip is to the west, northwest. Areas V, VI, and VII are within the area of influence of a northwest trending salient of the Ozark uplift, trending through the Lake of the Ozarks area. Bedrock dip is generally north-northeast on the north side of the arch and south and southwest on the south side of the arch. Local deviations of geologic structures in the various regions will influence bedrock considerably.

The Western Plains province which includes Areas I, II, III, IV, and V is part of the large Great Plains area east of the Rocky Mountains. It is generally the most flat-lying portion in the Basin. The sedimentary rock layers in these five areas dip generally to the west and northwest so that the older rocks are exposed in the east and the younger rocks exposed in the west. These broad bands of exposed rock strata are roughly the boundary lines of the numbered areas.

Glaciation did not extend into the Western Plains area. However, the large amount of water flow during periods of glaciation contributed to its development. This is reflected in both the wide stream channels and alluvium filled valleys.

The region represented by the Ozark physiograph province is outlined by Areas VI and VII. This region, the Salem Plateau, is characterized by rough topography, forested hills, and deeply entrenched meandering streams. Caves, sinkholes, and large springs are distinguishing features. Vertical bluffs

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JACKSON
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VERSAILLES
MORGAN
OSAGE
CLINTON
KAYSINGER BLUFF RESERVOIR
BENTON
HENRY
BUTLER
BATES
TUSCUMBIA
LAKE OF THE OZARKS
MARIES
VIENNA
WARSAW
ST. CLAIR
MILLER
OSCEOLA
HICKORY
HERMITAGE
CAMDEN
PULASKI
CAMDENTON
VERNON
NEVADA
POMME DE TERRE RESERVOIR
CEDAR
DALLAS
POLK
LEBANON
LACLEDE
STOCKTON
BUFFALO
BOLIVAR
STOCKTON RESERVOIR
DADE
BARTON
GREENFIELD
GREENE
MARSHFIELD
WEBSTER
SPRINGFIELD
LAWRENCE
CHRISTIAN
KANSAS
MISSOURI
94°
93°
92°
38°
37°

LEGEND

I — Cyclic deposits of limestone, shale, and siltstone. Several prominent limestone units. (Pennsylvanian System - Kansas City Group)

II — Predominantly shale and sandstone. (Pennsylvanian System - Pleasanton Group)

III — Cyclic deposits of shale, sandstone, limestone, clay and coal. (Pennsylvanian System - Marmaton Group)

IV — Cyclic deposits of shale, clay, coal and sandstone with minor limestone units. Several important coal beds. (Pennsylvanian System - Cherokee Group)

V — Predominantly limestone; cherty in part. Prominent siltstone unit in southern part. (Mississippian System - Meramecian, Osagean & Kinderhookian Series)

VI — Predominantly dolomite, massive to flaggy, cherty in part; minor sandstone units. (Ordovician System - Canadian Series, Cotter & Jefferson City Formations)

VII — Predominantly cherty dolomite and sandstone. (Ordovician System - Canadian Series, Roubidoux & Gasconade Formations; Cambrian System - Upper Series, Eminence Formation)

LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° AND 45°

SCALE 1/875,000
SCALE 10 0 10 20 30 MILES

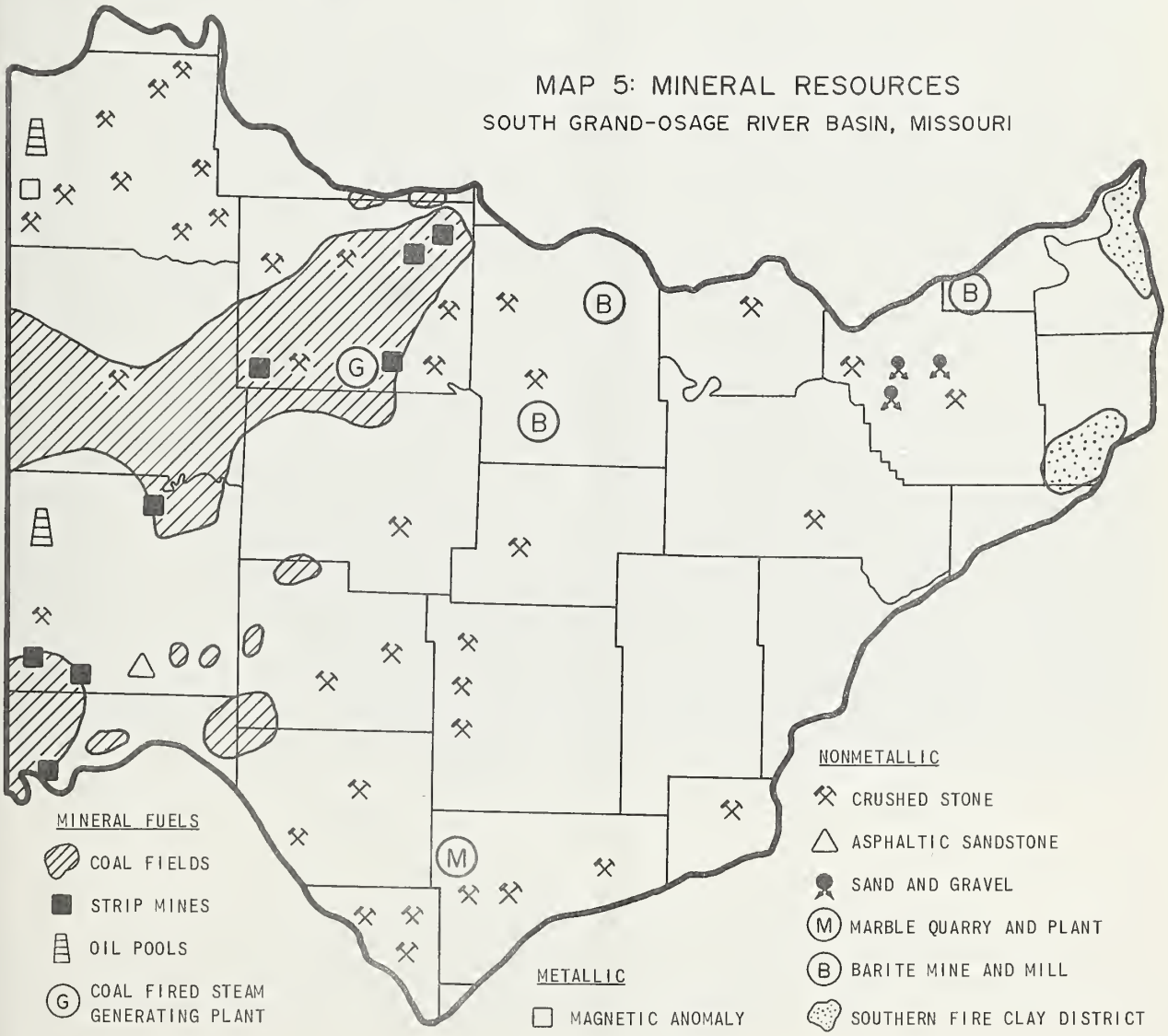
SOURCE
SCS DRAWING NO. 5,P-25309 AND DATA PROVIDED BY MISSOURI DIVISION OF GEOLOGICAL SURVEY AND WATER RESOURCES.

MAP 4
GENERALIZED GEOLOGIC MAP
SOUTH GRAND-OSAGE RIVER BASIN
MISSOURI

9-19-69
5,P-27603

100 feet or more in height are common. The ridges in most areas are flat and narrow, but considerable expanse of rolling country intervenes between. During repeated geologic uplifts and long periods of erosion, the young sedimentary rocks were largely removed. Therefore, the exposures of rocks in the Ozark portion are of much greater age than the surface formations throughout the remainder of the Basin toward the west.

Mineral deposits include mineral fuels, non-metals and metals. Only mineral fuels and non-metallic minerals are of present economic importance. The principal resources are coal and stone which represent more than 90 percent of the total annual value of mineral production in recent years. Other mineral commodities being extracted are: asphaltic sandstone, sand and gravel, clay and shale, crude petroleum, dimension sandstone and barite (Table 2). None of the known metallic mineral deposits -- iron, lead, and zinc are being mined. The locations of known mineral producers are shown on Mineral Resource Map (Map 5).



SOURCE:
MISSOURI DIVISION OF GEOLOGICAL SURVEY AND WATER RESOURCES

Table 2. Production and Annual Value of Mineral Commodities for Selected Years: South Grand-Osage River Basin, Missouri

		1955	1960	1967
Asphaltic sandstone	(tons)	-W-	-W-	-W-
Clay and shale	(tons)	-W-	-W-	-W-
Coal	(tons)	2,284,656	1,934,827	-W-
Oil	(bbls)	12,867*	8,179*	-W-
Sand and gravel	(tons)	331,829	253,176	82,000
Stone	(tons)	1,440,400	1,611,040	2,123,063
Annual Value	(dollars)	12,426,000	12,417,000	13,024,000

-W- Withheld - company confidential data.
* Includes production from southern Jackson County.

D. Land Resources

General information on land resource areas and soils is presented in this section. Analysis of soil productivity and land use gives additional information on the land resource base.

1. Land Resource Areas

The Major Land Resource Areas represented are LRA 107, 112, 115, and 116. For the purpose of this report, about 20,000 acres of LRA 107 in the northwest corner of the Basin were combined with LRA 112. Also, about 50,000 acres of LRA 115 in the Lower Osage were combined with LRA 116 (Map 6).

MAP 6: LAND RESOURCE AREAS
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI

Land Resource Area 112, Cherokee Prairies, is an old plain with nearly level to gently sloping relief. Some low hills occur in the eastern part where LRA's 112 and 116 merge. Stream valleys are generally wide and flat with approximately 12 percent of the drainage area in bottomland.

Soils are derived from the Pennsylvanian shales and sandstones with a silty, loess surface mantle. They are primarily dark or moderately dark colored, silty prairie soils of medium acidity in the northern part grading into lighter colored, strongly acid, highly leached soils in the southern part. Scattered timber tracts occur on the lighter colored soil areas, usually on the more rolling slopes adjacent to the streams.

Nearly level old plain of the Cherokee Prairies - Land Resource Area 112.

Land Resource Area 116, Ozark Highland, is a highly dissected old mountain range with narrow, gently rolling divides and steep, stony side slopes. The area is largely timber covered and characterized by steep slopes and stony soils derived from Mississippian and Ordovician limestone, dolomite and chert.

Photo by: Woolridge - Missouri Department of Conservation

Scenic and hilly Ozark Highland - Land Resource Area 116.

The soils, mostly light colored, shallow and stony, were developed under timber vegetation; but some areas of deeper soils with rock-free surface occur on the gentler slopes on wider ridges adjacent to the western boundary where LRA's 112 and 116 merge. The stream valleys are primarily narrow, subject to flash flooding and consist of soils of variable depth, texture, and drainage. The bottomland makes up approximately four percent of the drainage area.

The predominant soils are gathered into nine groups described in the legend of the Generalized Soils Map (Map 7).

2. Land Capability Classification

Land Capability Classes consist of soils having similar characteristics and degree of problems. The nature of soil properties, the steepness of slope, amount of erosion, wetness, and other factors are considered in the placement of soils. In the broadest sense, the capability class indicates the types of use to which the soil is suited and the intensity level of management required to conserve the soil in specific use. Land Capability Classes by Land Resource Areas are shown in Figure 1.

U. S. DEPARTMENT OF AGRICULTURE — ECONOMIC RESEARCH SERVICE — FOREST SERVICE — SOIL CONSERVATION SERVICE

LEGEND

1 DEEP, DARK, ROLLING PRAIRIE AREA
Gently rolling to rolling upland with deep, dark, moderately to slowly permeable soils predominating. Some areas of limestone and shale outcrop occur. Small stream bottoms also occur along drainage tributaries. Major problems are erosion and wetness. Principal soils are Shorpsburg, Grundy, Summit, and Snead.

2 UNDULATING, MIXED PRAIRIE AREA
Undulating upland with dark and moderately dark, moderately to slowly permeable soils. Significant areas of nearly level, gray, claypan prairie and poorly drained small stream bottoms are included. Some rock and shale outcrops occur on steeper slopes. Major problems are erosion and slight wetness. Principal soils are Summit, Woodson, Parsons, Dennis, Bates, and Barden.

3 CLAYPAN PRAIRIE AND PRAIRIE SANDSTONE AREA
Nearly level to undulating upland with moderately dark colored, slowly and very slowly permeable soils. The very slowly permeable claypan soils occur on the more nearly level areas. Moderately to slowly permeable brown soils developed from sandstone and shale occur on the slopes. Slowly permeable stream bottoms are included. Major problems are erosion, wetness, and droughtiness. Principal soils are Cherokee, Carytown, Parsons, Dennis, Bates, and Barden.

4 SANDSTONE SOIL AREA
Undulating to rolling uplands of soils of variable depth, texture, permeability and stoniness; derived from sandstone. Major problems are droughtiness, erosion, and stone content. Principal soils are Bates, Collinsville, Barco, Carytown and soils presently referred to as Bolivar and Boone.

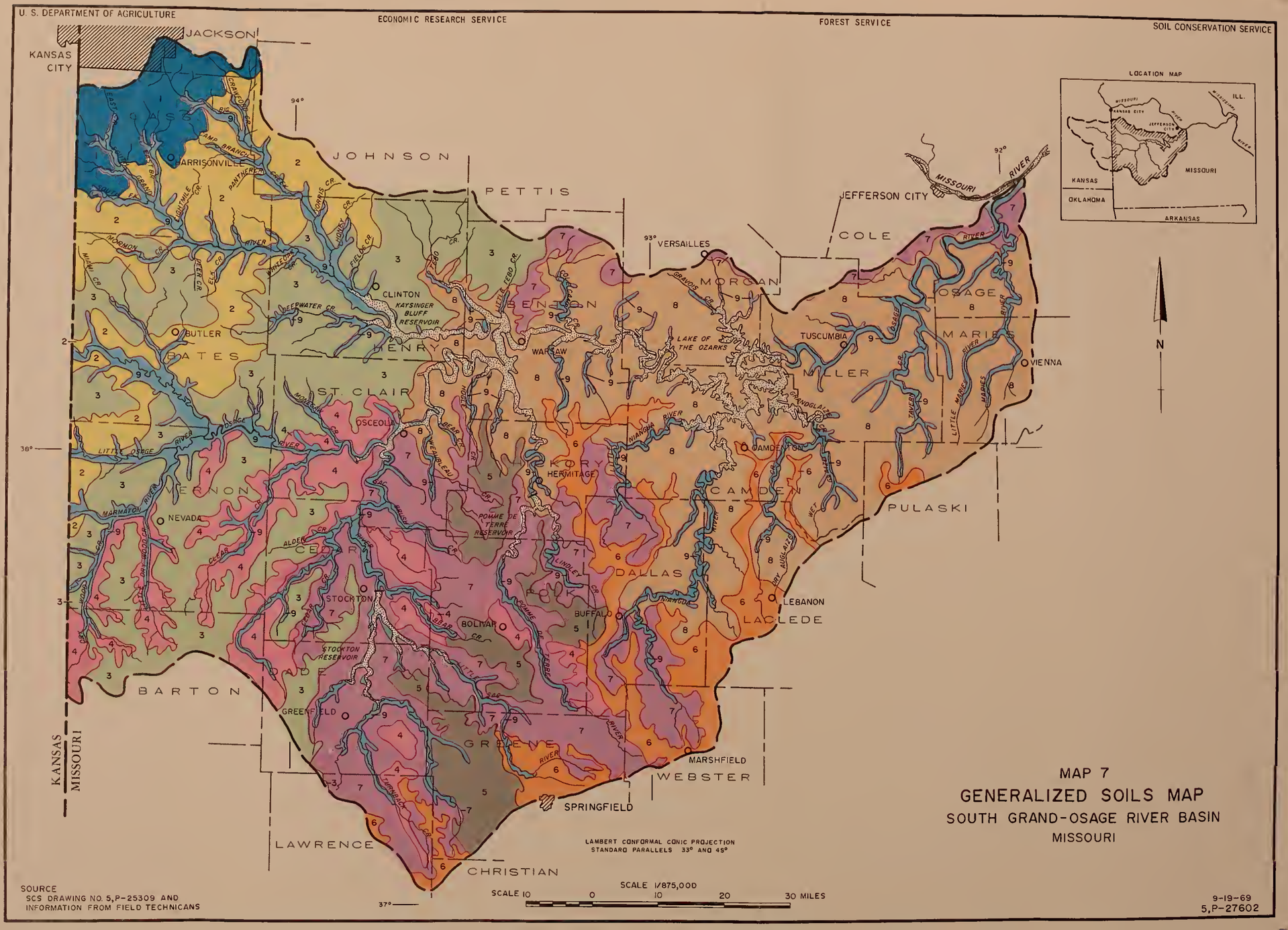
5 REDDISH-BROWN FOREST AND PRAIRIE SOIL AREA
Undulating to rolling and hilly soils generally moderately to slowly permeable, with silty surface soils, and cherty subsoils at 26 to 40 inch depth. Major problems are erosion, droughtiness, and flash flooding on the associated narrow bottoms. Principal soils are Newtonia, Eldon, Eldorado, and Creldon on the undulating areas and Baxter on the rolling areas.

6 MIXED PRAIRIE AND "FLATWOODS SOIL" AREA
Undulating to gently rolling soils and associated small creek bottoms. Soils vary from light in timbered areas to dark in prairie areas. Permeability varies from moderate to very slowly permeable with fragipan horizons (hardpan) on the more nearly level areas. Surface soils are normally silty with chert content normally increasing with depth. Major problems are wetness and droughtiness with erosion on the sloping areas. Principal soils are Gerald, Lebanon, Eldon, Bado, Baxter, and Creldon.

7 ROLLING TO HILLY CHERTY UPLANDS
Gently rolling to hilly cherty uplands and associated stream bottoms. The soils are primarily reddish brown and yellowish brown, moderately well drained soils which contain small amounts of chert in the surface and increasing with depth. Frequent limestone "glade" areas are common. Major problems are erosion, leaky ponds, droughtiness, stone content, and flash overflow on bottoms. Principal soils are Baxter, Eldon, Newtonia, Nixa, and Clarksville with loess capped Union and Winfield in this area north of the Osage River.

8 STEEP, STONY SOIL AREA
Primarily rough stony areas with associated narrow ridges and narrow stream valleys. Slopes are steep, nearly all soils have high chert content. Most areas are in timber. Major problems are limited land use adaptability, droughtiness, stone content, and flash flooding in the narrow bottoms. Principal soils are Clarksville and Wilderness stony silt loam.

9 BOTTOMLAND AREAS
This area outlines the approximate major valley flood plains. Soils are mixed and vary from clay to sand and gravel bars. Primarily the broader valleys (upper tributaries) are imperfectly to poorly drained silt loams and silty clays, with significant occurrence of clay (gumbo). The lower reaches are narrow, and more mixed but contain higher amounts of well drained soils that are often droughty due to sandy and gravelly subsoils. Major problems are wetness, droughtiness, flooding, stream channel scour, and deposition. Principal soils are Verdigris, Lightning, Osage, Askew, Lanton, Cleora, Radley (western tributaries) and Huntington, Linside, and Dunning in lower reaches.



LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° AND 45°

SCALE 1:875,000
SCALE 10 0 10 20 30 MILES

SOURCE
SCS DRAWING NO. 5,P-25309 AND INFORMATION FROM FIELD TECHNICANS

MAP 7
GENERALIZED SOILS MAP
SOUTH GRAND-OSAGE RIVER BASIN
MISSOURI

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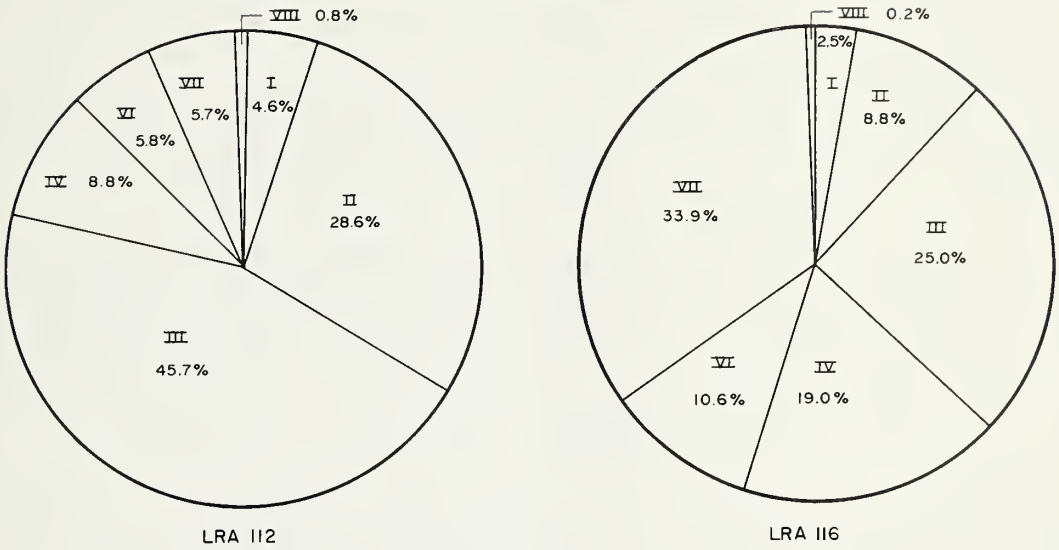
FIGURE I: DISTRIBUTION BY LAND CAPABILITY CLASSES
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Land Resource Area 112 has 87.7 percent and LRA 116 has 55.3 percent in land suitable for many uses -- Classes I through IV lands are described below:

Class I - Very good soils that are nearly level, easily worked, have practically no hazards, and can be used for cultivated crops safely with ordinary good farming methods.

Class II - Good soils that are suitable for the use of cultivated crops with extensive (simple, inexpensive, or easily applied) conservation practices to overcome minor hazards such as a slight erosion potential, slight wetness, and slight droughtiness. Soils in this class commonly have gentle slopes.

Class III - Moderately good soils that can be cultivated safely if supported with intensive conservation practices to overcome one or more major hazards, such as erosion, wetness, or stoniness. Soil and water conservation measures necessary to overcome these limitations are often expensive or complicated to install and to maintain. Some soils in this class are sloping.

Class IV - Soils only fairly good that usually have hazards so severe that they may be cultivated only with extreme care. The installation and maintenance of the needed conservation practices that would permit cultivation of these soils would have questionable economic feasibility except under favorable local conditions. Therefore, hay or meadow crops which require only occasional cultivation are usually recommended.

Land Resource Area 112 has 12.3 percent and LRA 116 has 44.7 percent of its land limited in its uses -- Description of Classes V through VIII follows:

Class V - Nearly level soils that are best suited to permanent vegetation. These soils are too stony, too wet, or too frequently subject to damaging overflow for cultivation.

Class VI - Soils that are too steeply sloping, too severely eroded, too wet, too stony, or too droughty, alone or in combination, for practical cultivation. Recommended use is usually for grazing or forestry with reasonable care and management. Some soils in this class can be renovated for pasture improvement.

Class VII - Soils that are too steep, too stony, too droughty, too wet, or too eroded, alone or in combination, for cultivation. The hazards exceed those in Class VI. Recommended use is usually for pasture or timber with extreme care in management. Cultivation is neither safe nor practical with present known methods. Some soils in this class are best protected without use, or with very limited use, in order to conserve water and protect better, lower-lying soils.

Class VIII - Soil areas that are very steep, very stony, very sandy, or very wet. Some such areas consist essentially of rock outcrop. They are best suited for wildlife food and shelter areas or for recreational purposes. Most soils in this class are best protected without use in order to conserve water and protect better, lower-lying soils.

Acreages of land by Capability Classes are shown in Table 3.

Table 3. Land[1/] by Capability Classes: South Grand-Osage River Basin, Missouri

Class	LRA 112 Acres	LRA 116 Acres	Total Acres
I	109,100	100,000	209,100
II	678,400	353,000	1,031,400
III	1,083,600	998,200	2,081,800
IV	208,300	758,800	967,100
V	-	300	300
VI	137,900	423,900	561,800
VII	136,400	1,348,400	1,484,800
VIII	19,900	7,400	27,300
TOTAL	2,373,600	3,990,000	6,363,600

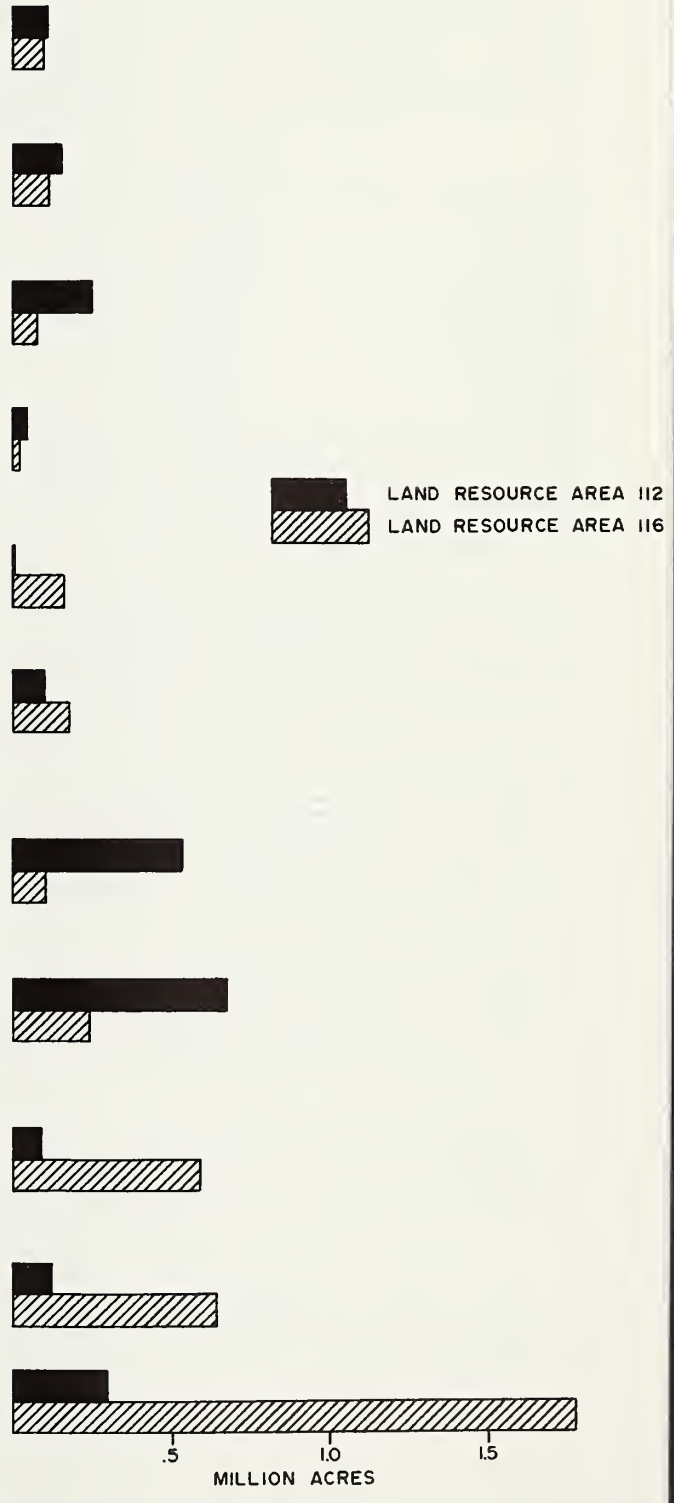
1/ Does not include urban or federal land or water areas.

3. Soil Resource Productivity Groups

For the purpose of analyzing the costs of producing projected agricultural requirements in the Basin, soils were aggregated into 11 Soil Resource Productivity Groups (SRG's). Crop yields, cost of production, and soil potential are relatively homogeneous within these groups. Soil groups A through F occur on flood plains, and the extent to which they flood is indicated in Table 4. Soil groups G through K occur in upland areas.

Table 4. Soil Resource Productivity Groups: South Grand-Osage River Basin, Missouri

Soil Resource Group	Percent of Total Area	Soil Group Description and Distribution by Land Resource Areas
Flood Plain Soils:		
A	3.3	Deep medium textured, moderately to slowly permeable. Level to gently sloping. 56 percent floods. The flood-free soils in this group are the highest yielding soils in the Basin.
B	4.1	Poorly drained medium textured, slowly permeable. Includes seasonably wet areas due to seepage. Level. 45 percent floods. Yields from this soil are slightly lower and costs higher than group A due to soil wetness condition.
C	5.1	Deep planosols with fine textured subsoils, very slowly permeable. Nearly level. 15 percent floods. Yields lower than group B due to soil wetness and texture. Costs same as group B.
D	1.1	Deep, poorly drained, medium to fine textured. Slowly to very slowly permeable. Level to nearly level. 92 percent floods. Yields lower than group C due to more severe wetness but costs about the same.
E	2.6	Well to moderately well drained. Medium to moderately coarse textured soils overlying sand and gravel. Nearly level to sloping. 5 percent floods. Yields lower than group D due to soil texture and subsoil. Costs lower than group D.
F	4.3	Well drained medium to coarse and gravelly. Level to sloping. 3 percent floods. Yields lower than group E due to soil texture and subsoil. Costs same as group E.
Upland Soils:		
G	10.0	Deep, well to somewhat poorly drained. Medium to fine textured. Moderately to slowly permeable soils with firm subsoils. Highest yielding and lowest production costs of upland soils. Yields compare with group C.
H	14.3	Same as group G except sloping up to moderately steep (14 percent slope) including eroded phase. Lower yields and higher costs of production than group G due to more erosion.
I	10.6	Well to moderately well drained. Medium to moderately coarse textured subsoils over chert rock or limestone. Low water holding capacity. Slopes of from 2-9 percent. Lower yields than group H due to soil texture and subsoil. Costs same as group H.
J	12.0	Same as group I except eroded or up to 14 percent slope. Lower yields than group I and higher costs due to steepness and erosion.
K	32.6	Deep to shallow mostly stony soils with rock outcrops on variable slopes. Lowest yielding soil group due to steepness, soil texture and soil fertility.



4. Land Use

Although the climate of the two Land Resource Areas is similar, physical features and land use are different. About one-third of the Basin is forested, one-third is cropland, and 22 percent is pasture. The remaining 11 percent is divided between other agricultural uses, urban use, water areas and Federal ownership and use (Table 5).

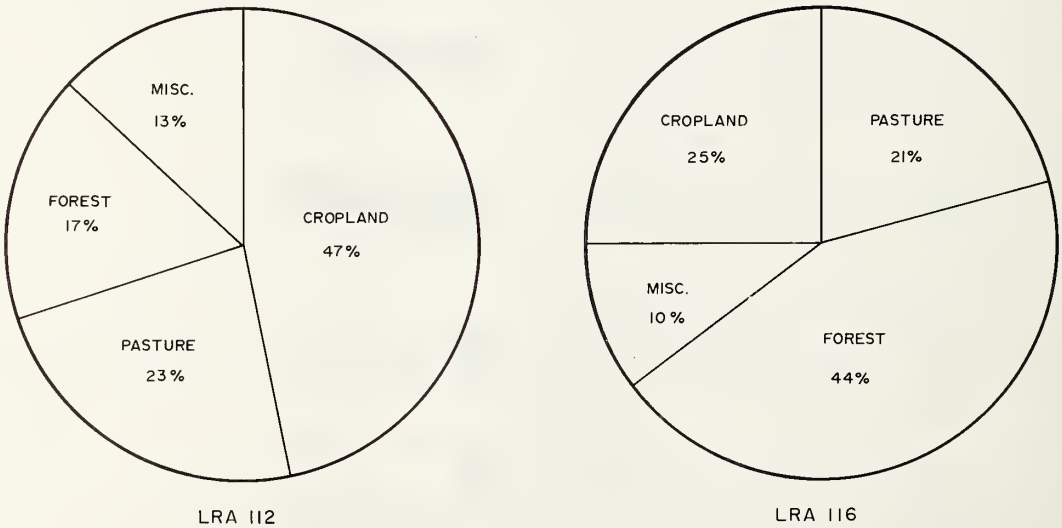
Table 5. Land Use: South Grand-Osage River Basin, Missouri

	(in thousands)					
	LRA 112		LRA 116		Total	
Land Use	Acres	%	Acres	%	Acres	%
Forest	427.2	17	1,898.0	44	2,325.2	34
Cropland	1,196.8	47	1,087.5	25	2,284.3	33
Pasture	578.9	23	916.2	21	1,495.1	22
Other 1/	170.7	7	88.3	2	259.0	4
Urban	106.8	4	172.5	4	279.3	4
Water	26.6	1	106.9	2	133.5	2
Federal	24.0	1	81.0	2	105.0	1
TOTAL	2,531.0	100	4,350.4	100	6,881.4	100

1/ Other agricultural lands.

Almost half of Land Resource Area 112 is cropland, while only a fourth of LRA 116 is in this use (Figure 2). Conversely, only 17 percent of LRA 112 is forested compared to 44 percent of LRA 116.

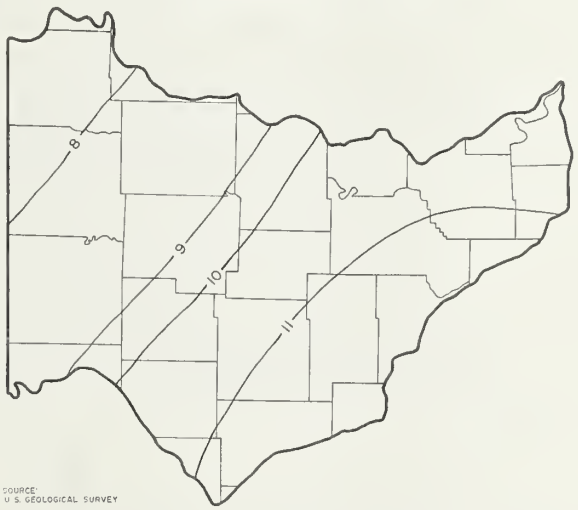
FIGURE 2: LAND USE — SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



E. Water Resources

Annual yields from streams in the Cherokee Prairies Land Resource Area are the lowest in the Basin. The average annual runoff volume for the Osage River gage at Osceola and the South Grand River at Brownington is 8.0 and 8.4 inches, respectively. The range in annual runoff on these gages is from 0.5 inch to 21.6 inches. See Map 8 for average annual runoff.

MAP 8: AVERAGE ANNUAL RUNNOFF IN INCHES
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Because of higher annual rainfall and flow from springs, higher average annual runoff and better low-flow characteristics are recorded in the Ozark Highland Land Resource Area. Fed by Bennett and smaller springs, Niangua River near Decaturville has an average annual yield of 13.6 inches, while annual runoff ranges from 4.0 to 23.9 inches.

March, April, and May are consistently high runoff months in both land resource areas. The six-month period from January through June averages 67 percent of the total runoff, while July through December averages only 33 percent.

Springs are a natural feature of the Ozarks. Bennett Springs, located in Dallas and Laclede Counties, has an average discharge of 100 million gallons per day. Other relatively large springs are Wet Auglaize and Hahatonka in Camden County and Blue Springs in Laclede County.

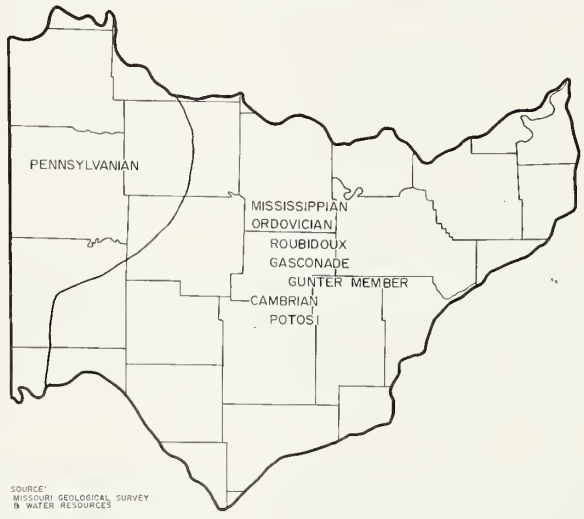
The quality of the water in the Marais des Cygnes, Marmaton, and Little Osage Rivers is good, although it is very hard and higher in mineral content than most streams in Missouri. Since the discharge in these three streams is almost entirely from surface runoff, they cease to flow during periods of drought. The mineral content mentioned before is derived from the surface soils in the area.

The Osage River below Bagnell Dam is controlled largely by releases of water from the Lake of the Ozarks through the power generators at the dam. However, leaks around the dam allow a continuous flow downstream even when the power-generating equipment is not operating. The quality of the stream below the dam is influenced by the releases from the dam.

The waters in the Lake of the Ozarks are generally of very high quality. Large resorts or heavily developed areas have caused a noticeable quality deterioration in a few coves.

Ground water available at moderate depths varies from excellent with high production in the eastern and southeastern counties to very poor in the western counties (Map 9). Deep aquifers in western Barton County have yield capabilities in excess of 1,000 gallons per minute of potable water. The variation in water production is directly related to geologic factors. Water from Pennsylvanian strata is generally poor in quality throughout this area, and yields are commonly low. Where Mississippian or Ordovician Age sediments are present, water sources are abundant and high in quality.

MAP 9: GROUND WATER AQUIFERS
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



In the Pennsylvanian formation, water production generally is limited to five to ten gallons of water per minute. Water obtained from the Pennsylvanian Age sands have iron, chlorides, and sulphates in greater amounts than the acceptable standards of the State Division of Health. Depth to water sources varies from 200 to 400 feet. Drilling below this depth in these counties will encounter highly mineralized water unsuited for human consumption.

In the Mississippian and Ordovician formations, water production from wells is adequate for industrial, municipal, and individual household use. Large quantities of potable water are available from the dolomites, sands, and

cherts of the Lower Ordovician and Upper Cambrian in depths from 500 to 1,750 feet. Production varies from 100 to 500 gallons of water per minute. Although not approved for public water supplies, wells for domestic use obtain 10 to 30 gallons per minute at depths of 250 to 300 feet.

Wells completed in the Gunter sandstone commonly produce as much as 250 to 500 gallons of water per minute. This available water is derived from the Gasconade and Roubidoux formations as well as the Gunter. In the Springfield area, 500 to 1,000 gallons of water per minute is available at a depth of approximately 1,750 feet. Wells in this area should be cased to a maximum of 400 feet or below the Swan Creek sandstone to eliminate pollution.

East of the Springfield area, approximately 500 gallons per minute is the average production from deeper aquifers in the Potosi Formation; and 100 gallons of water per minute from the Gunter. The more shallow aquifers in the Gasconade and Roubidoux formations produce 10 to 25 gallons of water per minute.

In the area of Mississippian and Ordovician bedrock, it is advisable to case below the Roubidoux formation. Most farm and domestic wells produce from this formation. The quality of the ground water in the eastern basin area is such that treatment is usually not needed if the wells are properly constructed. The total dissolved solids is usually less than 300 parts per million.

Water resources are being utilized in varying degrees for a multitude of purposes serving many interests. Existing water resource development includes single and multi-purpose reservoirs which are completed or under construction. Completed are the hydroelectric power installations of Bagnell and Osceola Dams on the Osage River and Tunnel Dam on the Niangua River, and the multi-purpose Pomme de Terre Reservoir on the Pomme de Terre River for the purposes of flood control, recreation, and fish and wildlife enhancement. Montrose Lake on Deepwater Creek provides water for a steam turbine generating plant and incidental recreation.

The present installed hydroelectric capacity is about 176,600 kilowatts at Bagnell, Osceola, and Tunnel Dams. This capacity will increase to about 380,200 KW upon completion of the 45,200 KW Stockton Dam and the 160,000 KW Kaysinger Bluff Dam. When Kaysinger Bluff Reservoir is complete, the Osceola hydroelectric plant will be inundated resulting in a loss of 1,600 KW.

Extensive recreational use is made of existing waters. Although Bagnell Dam was constructed as a single purpose power installation, the lake (Lake of the Ozarks) provides 65,000 surface acres of recreational area of national importance. Pomme de Terre Reservoir has a permanent pool surface area of 7,800 acres available for recreation, and the Stockton and Kaysinger Bluff Reservoirs will add 24,900 and 55,600 acres respectively for a total of 153,300 acres of water. The Niangua River provides about 40 miles of high quality open stream.

Agricultural water use is primarily for domestic and livestock watering; however, irrigation is used to supplement natural rainfall on a limited area. The acreage irrigated varies from year to year depending on many factors

including previous losses from drought and growing season rainfall. In 1954, one of the drier years, 83 farms in the 16 major counties irrigated 1,737 acres. In 1963, 2,900 acres were irrigated. Average annual water use per acre for irrigation is estimated at 0.8 acre-feet, while 1.5 acre-feet is required for a ten-year frequency drought. Deep wells have served as a source of irrigation water on one farm in western Barton County and may be expected to be utilized in the future.

Pomme de Terre Reservoir provides 407,000 acre-feet of flood control storage. Stockton Reservoir will add 782,000 acre-feet, and Kaysinger Bluff Reservoir will add 3,999,000 acre-feet.

About 61 communities have municipal water supplies. In addition, several industries have developed separate sources of supply (Table 6).

Table 6. Average Municipal and Industrial Use: South Grand-Osage River Basin, Missouri

Water Supply	Total	Surface	Ground
	mgd (Million gallons per day)		
Municipal	13.16	5.38	7.78
Total Industrial Self-Supplied	28.39	17.93	10.46
Mining	(20.84)	(10.42)	(10.42)
Thermal Electric	(7.51)	(7.51)	
Food Processing	(0.04)		(0.04)
Totals	41.55	23.31	18.24

Note: ( ) indicates non-cumulative; included in above total.

The percentage of households with hot and cold running water inside their homes increased from 38 percent in 1950 to 69 percent in 1960 (Table 7). The advent of rural electrification and organization of rural water districts are mostly responsible for this rapid increase.

Table 7. Domestic Water Facilities: South Grand-Osage River Basin, Missouri 1/

Type of Facility	Percentage of households by year		Gallons per day per household
	1950	1960	1960
	Percent	Percent	Gallons
Running hot and cold inside	38	69	150
Running cold inside	15	8	90
Running water outside only	2	2	50
No piped water	45	21	
	100	100	

1/ Based on U. S. Census of housing data for 16 major counties in Basin.

At present, 27 rural water districts cover approximately 11 percent of the total area and serve about 987 families. When these districts are developed to their expected potential, about 3,100 families will be served.

Private investment has been a large factor in water resources development. Bagnell Dam is privately owned and financed, and with the exception of the Lake of the Ozarks State Park, essentially all the recreation development around the reservoir is private. Private industry utilizes about 68 percent of the municipal and industrial water. Privately owned utilities furnish municipal water supply to Nevada and Clinton. The Osceola Dam and Montrose Lake are owned by private utilities.

Photo by: Woolridge - Missouri Department of Conservation

Montrose Lake - a water supply developed by a private utility also provides recreational opportunities.

F. Fish and Wildlife Resources

Fish and wildlife resources are extremely important to the Basin population and to the bordering Kansas City and Springfield metropolitan areas. Important fish species in the warm and sometimes turbid streams are largemouth bass, channel catfish, various sunfish, crappies, and bullheads. Smallmouth bass, rock bass, longear sunfish, darters, and others are common in the clearer Ozark-type streams.

Hunted upland game species include bobwhite quail, cottontail rabbits, fox and gray squirrels, and mourning doves. Two species, the white tailed deer and wild turkey, are considered big game species. Fur species found are muskrat, mink, raccoon, opossum, gray and red fox, skunk, and beaver. Raccoons, opossums, and foxes are harvested by hunting and trapping.

Waterfowl from the Central and Mississippi Flyways use the Basin during fall and spring migrations. Canada, blue, snow, and white fronted geese are found in the above order of relative abundance.

Ducks in order of abundance are the mallard, pintail, wood duck, ring-necked duck, lesser scaup, green winged teal, and blue winged teal.

Prairie chicken habitat in the Basin is some of the best in the State. Although the prairie chicken is not hunted in Missouri, it continues to have aesthetic appeal.

Small impoundments such as farm ponds and strip mine lakes are of local importance in providing fishing and hunting activities.

Photo by: Woolridge - Missouri Department of Conservation

Hunted game includes quail, dove, rabbit, squirrel, turkey, and deer.

G. Quality of the Natural Environment

The natural environment is one of great variety. To the south and east, scenic hills and clear Ozark-type streams fed by flowing springs attract many visitors. Forested, rugged topography provides the setting for large impoundments having extensive water areas for fishing and other recreational pursuits. Wildlife provides countless opportunities for sportsmen to pursue their interest. Along the wooded streams and in the forests, a multitude of non-game species add to the enjoyment of hikers, boaters, and campers.

In the western portion of the Basin, the rolling prairies and wide bottomlands support intensive agricultural enterprises. Strip pits and farm ponds are of local importance in providing fishing and hunting opportunities. The quality of environment is endangered by the failure to reclaim land devastated by strip mining and the pollution problems thus created.

III. ECONOMIC DEVELOPMENT

The present economy of the Basin is a result of historical development, location, social structure, institutions, and the quality and quantity of the natural resources and people. The future economy will be influenced by the historical trends, but the direction and extent of changes will be modified by influences outside the Basin and the desires of people in the Basin. Past trends and future projections of change are analyzed for several indicators of the economy to provide a basis for considering the needs for water and related land resource development.

A. Historical Development

The Shawnee, Kickapoo, and principally the Osage Indians were the first inhabitants of the Basin. Halley's Bluff between Warsaw and Osceola, Missouri, and the area which is now Kansas City, Missouri, are known to have been populated by large concentrations of the Osage tribes during the 1820's. The Osage was an agriculturally progressive tribe recognized for their ability to grow and store corn, squash, beans, nuts, and berries.

The Basin, first under French control, then under Spanish control, and again under French control, became a U. S. territory as a part of the Louisiana Purchase in 1803. Hunters, trappers, and settlers interested in the Ozark Highland's rich mineral and lumber resources were responsible for early economic development. These people, many of Scotch-Irish and French descent, came from Virginia, Kentucky, Tennessee, and the Carolina's in the 1820's and 1830's.

German farmers and immigrants from northern Europe were instrumental in the agricultural development. They cleared forested areas along streams to raise corn, wheat, oats, and barley and also expanded farming into the previously undeveloped western prairies.

Livestock production was a necessary part of the agricultural development. Cattle raised in the area were driven to markets in Lexington and Boonville. Brine pork, pickled beef, cheese, and other livestock products were exported by steamboat.

Warsaw and Osceola, Missouri, became important pre-Civil War trade centers. Their location on the upper navigable reaches of the Osage River made them the export centers for fur, lumber, and agricultural products. Prior to the development of rail transportation, commercial tonnage on the Osage River reached a yearly maximum of over 100,000 tons. Both towns were burned during the Civil War and both failed to acquire a major railroad, thus lessening their economic significance.

The area which is now Greene County was known as a trading and lumber center as early as 1802. An influx of immigrants from Illinois, Indiana, Ohio, Tennessee, and Kentucky increased the population of Springfield (in Green County) from 500 in 1830 to about 5,500 by 1870. It became an important rail shipping point for the grain and livestock produced in the area.

With the development of road and rail transportation routes in the 1880's, coal mining became an important early industry. Coal was taken from shaft mines until the development of surface strip mining. The first shovel for surface mining of coal was placed in operation by the Keith & Prairie Coal Company near Deepwater, Missouri, in 1912.

Bagnell Dam, a hydroelectric project constructed by Union Electric Company, was placed in operation in 1931. The dam stimulated economic activity by providing electric power and some minor flood control on the Osage River below the dam and extensive recreational development on the Lake of the Ozarks.

Agricultural production continues to be the economic foundation of the area, supplemented by the lumber and mining industries. Strategically located towns and two larger metropolitan areas provide most of the consumer goods and services. The scenic land and water resources are becoming increasingly important as nationally recognized recreation assets.

The Cherokee Prairies, Land Resource Area 112, was never a heavily forested area. Early pioneers found belts of timber ranging from 100 feet to three or four miles wide along all the major drainages. The remaining land was in native grasses. These sparse forest areas were soon further reduced as man's quest for farm land and material to build towns, homes, and railroads continued.

The forests of the east were more extensive. Almost all the region was originally forested. Logging progressed on an extractive bases, and most of the high quality hardwoods fell before the ax. By 1930, little remained of the Ozark's high-quality timber. The area, not ideally suited to farming, quickly reverted to lower quality second growth. Fires caused by carelessness or to clear the little farmable land burned over half of the forests annually. This, combined with widespread grazing, damaged the remaining vegetative cover and reduced the ground cover on steep hillsides.

In the early 1940's, the newly created Missouri Conservation Commission established a forestry branch to protect the forest land of the State from fire. This effort was aided by the U. S. Forest Service through the Clarke-McNary Cooperative Fire Control Program. The State Forestry Act was later passed to help owners protect their timberland from fire and timber stealing and to encourage permanent management by deferring payment of taxes with substitution of a "yield" tax payable at the time of harvest.

Under other Federal-State forestry programs, forestry services were offered to private landowners to further the protection of watershed values and provide a timber resource for the future. Many private landowners have improved and increased the value of their holdings through good management. Lumbering, charcoaling, and other forest industries have become permanently established and meaningful parts of the economy.

B. General Description

1. Population

Population of the Basin was about 253,300 in 1960 (Table 8).

Table 8. Population by Counties: South Grand-Osage River Basin, Missouri

County	Total Population of Counties 1/	Population in Basin	Percentage of Population in Basin
	Number	Number	Percent
Barton	11,113	3,709	33
Bates	15,905	15,905	100
Benton	8,737	7,086	81
Camden	9,116	9,116	100
Cass	29,702	28,811	97
Cedar	9,185	9,185	100
Cole	40,761	3,008	7
Dade	7,577	7,251	96
Dallas	9,314	9,314	100
Greene	126,276	52,795	42
Henry	19,226	19,226	100
Hickory	4,516	4,516	100
Jackson	622,732	488	--
Johnson	28,981	3,550	12
Laclede	18,991	8,545	45
Lawrence	23,260	3,040	13
Maries	7,282	2,620	36
Miller	13,800	11,233	81
Morgan	9,476	2,281	24
Osage	10,867	3,413	31
Polk	13,753	13,753	100
Pulaski	46,567	2,578	6
St. Clair	8,421	8,421	100
Vernon	20,540	20,540	100
Webster	13,753	2,946	21
TOTAL	1,129,851	253,330	

1/ U. S. Census of Population, 1960.

The geographic distribution of the population is typical of many mid-western areas. The rural nature is reflected by the fact that although the land area includes 15 percent of the State of Missouri, only six percent of the population of the State reside here. The largest concentration of people is in and around the city of Springfield which lies on the southern boundary in Greene County. Only three other cities have populations of more than 5,000 -- Nevada, Clinton, and Lebanon. Seven additional cities have populations of from 2,500 to 4,999. About 35 percent of the people live in these eleven urban cities. About 30 percent of the people are active farmers and live on farms, and the other 35 percent live either in the country or in one of the 104 small towns (Table 9).

Other population centers, which lie completely outside the Basin but have an important impact on the economies and resource use, include: Kansas City, with over a million people at the northwest tip; Jefferson City, with 28,000 people, to the northeast; and Fort Leonard Wood, in Pulaski County to the southeast.

Table 9. Population by Place of Residence, 1960: South Grand-Osage River Basin, Missouri

Population Classification	Number of towns	Population	Percentage Distribution
Rural farm:		75,210	29.7
Rural non-farm:			
Not in towns	--	51,457	20.3
Less than 500	81	15,387	6.1
500 to 999	13	9,014	3.5
1,000 to 1,499	7	8,331	3.3
1,500 to 1,999	1	1,699	.7
2,000 to 2,499	2	4,434	1.7
	104	90,322	35.6
Urban:			
2,500 to 4,999	7	23,977	9.5
5,000 to 10,000	3	23,561	9.3
Springfield 1/	1	40,260	15.9
	11	87,798	34.7
TOTAL		253,330	100.0

1/ Includes 42 percent of the population of the city in the Basin.

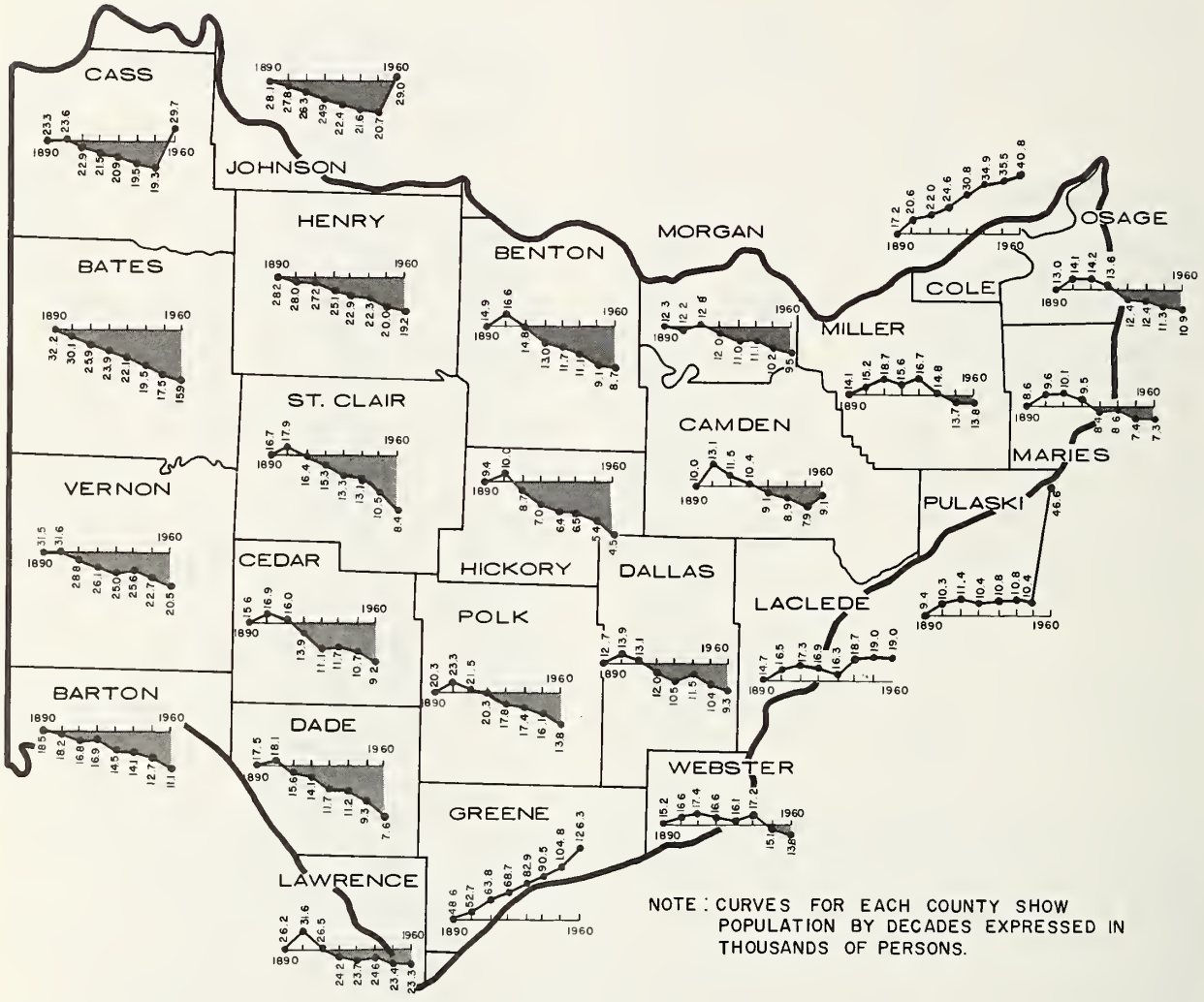
Population trends are similar to the trends in other rural areas of the Midwest. With the exception of Cass and Greene Counties, population was lower in 1960 than in the early 1900's (Map 10). Because of the economic growth of Springfield, a major trade center in the area, population in Greene County has increased consistently since 1890. It is the only county to sustain a positive gain in net migration since 1930. After 1950, the downward population trend in Cass County was reversed because of the expanding growth in the Kansas City metropolitan area. The downward trend in counties bordering the Lake of the Ozarks has either reversed or dampened since 1950. This reversal can be attributed to the recreational activity associated with the Lake.

The largest decrease in population occurred from 1940 to 1950 when the number of residents decreased by about 23,000 in the 15-county area or by about 8,900 when Greene County is included. Out-migration exceeded in-migration in all counties except Greene, Cass, and Camden from 1950 to 1960.

This net out-migration of people is caused by several factors. The substitution of machines for labor on farms has resulted in a lack of employment

MAP 10: POPULATION TRENDS BY COUNTIES, 1890-1960

SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI

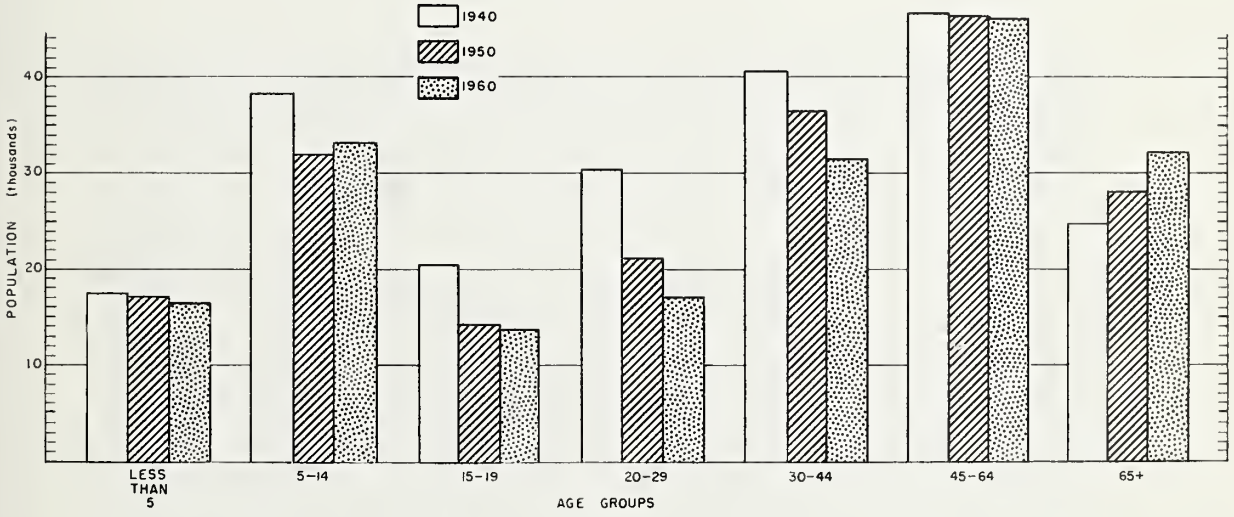


NOTE: CURVES FOR EACH COUNTY SHOW POPULATION BY DECADES EXPRESSED IN THOUSANDS OF PERSONS.

SOURCE: MISSOURI DIVISION OF COMMERCE AND INDUSTRIAL DEVELOPMENT

opportunities for the younger people and they have sought jobs elsewhere. This is illustrated by the changing age composition of the people remaining in the area (Figure 3). Note the decrease in the number of people under the age of 45, the stability in the age group 45 to 65, and the increase in the number of people 65 and over. The increase in the over 45 age group is explained by the lack of opportunity or desire by these people to leave the area and find jobs elsewhere, and also the in-migration of retired or semi-retired individuals as permanent residents around the Lake of the Ozarks. The medium age increased in all counties except the two metropolitan counties, Greene and Cass.

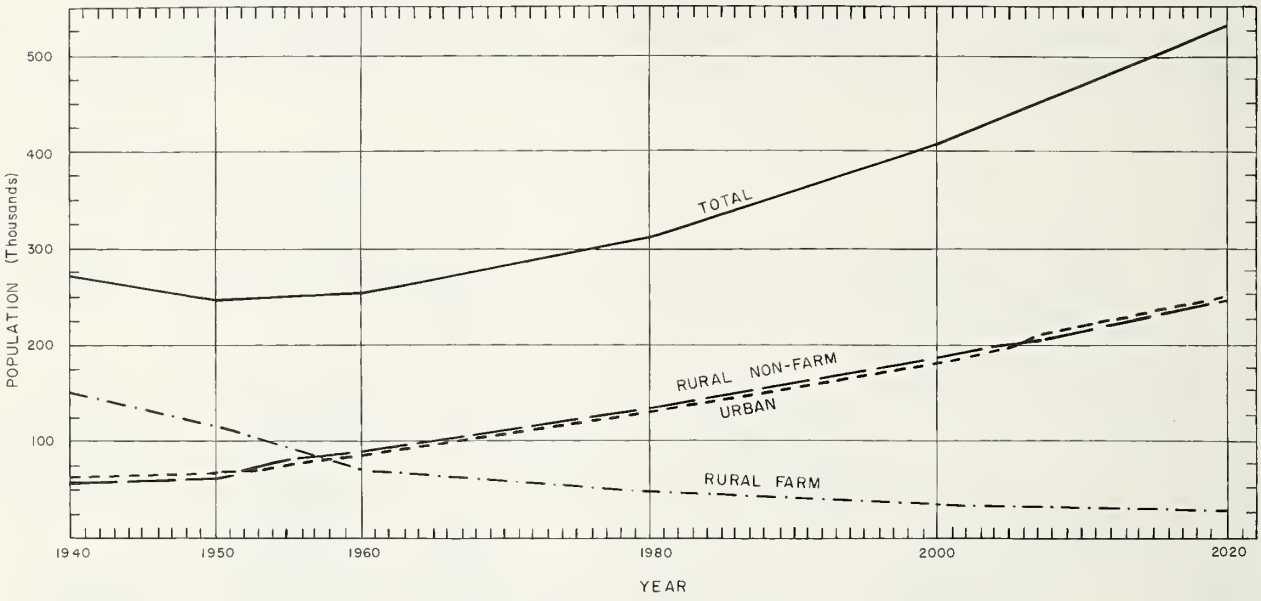
FIGURE 3: POPULATION AGE DISTRIBUTION BY YEARS, 15 REPRESENTATIVE COUNTIES SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



In general, the smaller towns have lost population while most of the larger ones have gained. Only 10 of the 81 towns with populations of less than 500 in 1960 had gains in residents since 1940. The total population of the 23 towns ranging in size from 500 to 2,500 remained about the same, as the gains in some towns were offset by losses in others. All 11 cities with populations of over 2,500 in 1960 have increased in size since 1940.

The major losses in population occurred in the rural farm group comprised of people living on and operating farms. This group decreased to half the 1940 level by 1960, a net loss of about 75,000 people (Figure 4). During the same time, the rural non-farm population consisting of people living in the country but not farming, or in towns of less than 2,500 people, increased at about the same rate as the urban population.

FIGURE 4: POPULATION TRENDS AND PROJECTIONS
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Total population is expected to increase in the future. The farm population will continue to dwindle but at a slower rate than in the past (Figure 4). The increase in urban and non-farm residents will more than offset this loss. Urban and rural non-farm residents are expected to continue to increase in number at about the same rate as in the past, resulting in a doubling of both by the year 2000. This growth is already evident and will probably be concentrated in three areas: (1) the towns and rural areas within 50 miles of Kansas City; (2) the city of Springfield and the rural areas around it; and (3) the area around the major reservoirs -- Lake of the Ozarks, Kaysinger, Pomme de Terre, and Stockton.

The Lake of the Ozarks will probably be one of the major growth areas, as it is already a regional recreation center; and several new marinas, resorts, summer homes, permanent retirement homes and recreational facilities have been built recently. This lake is especially attractive to people desiring summer or retirement homes because lots next to the shore of the lake are available.

The net effect of population growth in these major areas and losses in some rural areas is expected to result in an increase in population from 253,330 in 1960 to 312,000 in 1980, 407,000 in 2000, and 533,000 by 2020.

2. Social Structure and Institutional Arrangements

Social and institutional arrangements reflect the basic agricultural foundation. Communities are generally small and comprised of individuals with common ethnic, social, and economic interests. Many communities have a high degree of stability with generation after generation living on the same land. Other communities, however, are faced with problems of decreasing population and loss of economic vitality as inhabitants migrate to larger urban areas.

Governmental activity centers around the county seat. A larger town is often the site of the county seat and is likely to be the trade center for the county. A few of the counties are subdivided with townships as the smallest unit of government, but most are moving away from township organization in favor of the county form of government.

The schools range in size from small, rural units to those with large, modern facilities. Most of the small school districts have been consolidated into larger, more efficient units. Many of the rural students are bused to centrally located elementary and secondary schools in the larger towns.

Modern, consolidated, rural school.

The opportunities for higher education within the Basin include Southwest Baptist College at Bolivar, and Cottey College for women at Nevada. Springfield is the home of Southwest Missouri State College as well as several church-affiliated and private colleges. There are two Public Junior College Districts whose boundaries extend into the Basin area. The metropolitan Junior College of Kansas City serves parts of Jackson and Cass Counties. The State Fair Community College in Sedalia serves the greater part of Benton County. Central Missouri State College at Warrensburg, the University of Missouri at Columbia and Kansas City, Lincoln University at Jefferson City, and other area colleges serve the population.

Civic, religious, educational, and social organizations are active in many communities. It is to the credit of these groups that through them social progress is being made.

3. Employment and Economic Activity

Basic activities in the Basin include agriculture, manufacturing, mining, and forestry. The two most important industries are agriculture and manufacturing. Agriculture, with 22,000 workers or 25 percent of the total, is the major single source of employment (Table 10). Mining and forestry, while important segments of the economy, together employ less than 650 workers; 13,640 workers are employed in manufacturing. The importance of the forestry industry is reflected by the wood products manufacturing industry which employs 1,090 workers. Other important sources of employment in the manufacturing industries are food and kindred products with 2,150 workers and apparel and textile products with 2,160 workers. Altogether, manufacturing is the source of 16 percent of the jobs.

Table 10. Employment by Industry Group, 1960: South Grand-Osage River Basin, Missouri

Industry Group	Employment	Distribution
	Number	Percent
Basic Activity:		
Agriculture	21,940	25.0
Mining	540	0.6
Forestry and fisheries 1/	110	0.1
Manufacturing:		
Wood Products	(1,090)	(1.2)
Food and kindred products	(2,150)	(2.4)
Apparel and textile products	(2,160)	(2.5)
Printing and publishing	(1,010)	(1.1)
Electrical products	(1,200)	(1.4)
Other manufactured products	(6,030)	(6.9)
Total Manufacturing	13,640	15.5
Total Basic	36,230	41.2
Nonbasic Activities:		
Construction	6,170	7.0
Transportation and communication	4,570	5.2
Wholesale trade	2,390	2.7
Retail trade	13,450	15.3
Finance, insurance & real estate	2,360	2.7
Professional services	9,000	10.2
Public administration	3,020	3.4
Other services	10,780	12.3
Total Nonbasic	51,740	58.8
Total Basin	87,970	100.0

1/ Standard Industrial Classification Manual.

Employment in small manufacturing plants amounts to 16 percent of the total.

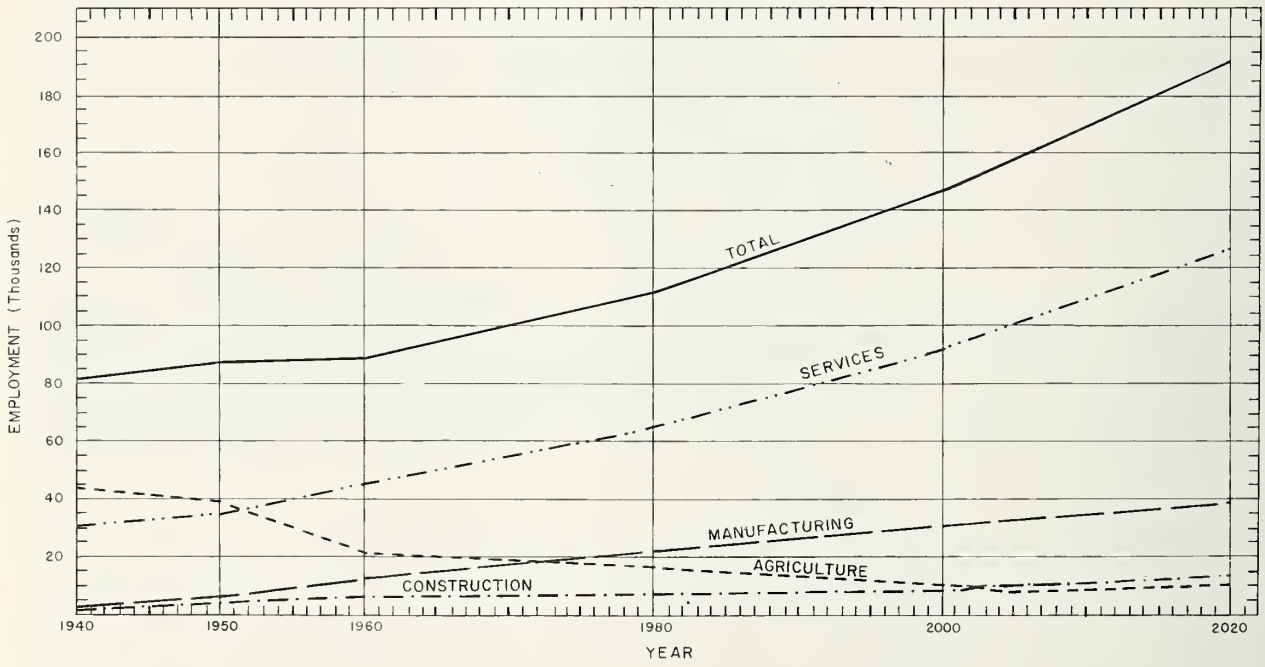
Construction, retail trade and services provide over nearly 60 percent of the employment.

The nonbasic industries, including construction, transportation, communication, and other trades and services, are indirectly tied to the basic industries. The importance of recreation is especially difficult to measure because it affects many of the nonbasic industries directly, but the extent to which it affects any of the given trades or services is almost impossible to measure.

Retail trade and construction were two of the most important nonbasic activities with 16 and 7 percent of the total employment respectively. Services account for about 29 percent of the total employment.

Although population decreased during the period from 1940 to 1950, total employment increased by about 7,000 workers or from 30 to 36 percent of the population. Multi-income families accounted for most of the increase (Figure 5). Total employment remained at about 88,000 from 1950 to 1960, while the employment rate slipped by one percent. Although workers in agriculture declined to about one-half the 1940 level by 1960, this reduction was offset by an increase in jobs in manufacturing, construction, and services. Employment in mining, like agriculture, declined steadily during this period even though production increased.

FIGURE 5: EMPLOYMENT TRENDS AND PROJECTIONS
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



SOURCE: SUBREGION 8, MISSOURI RIVER BASIN COMPREHENSIVE STUDY

The rate of employment is projected to remain at about 36 percent of the total population. This is lower than the 40 percent projected for the United States, because it is assumed that retired and semi-retired people will remain a significant proportion of the total population in the future. The recreational and rural areas will continue to hold middle-aged people already there and entice retired and semi-retired people into the area.

Employment in agriculture is expected to decrease but at a slower rate than in the past, reaching about half the current level by the year 2020, and shrinking from 25 to 5 percent of the total employment. Employment in manufacturing is expected to increase at about the same rate as in the past and comprise about 20 percent of the total employment. Workers in construction are expected to increase and continue to make up seven percent of the total employment. The services are expected to continue to make up a higher percentage of the employment, increasing from 59 percent of the total to 68 percent by the year 2020.

4. Income

Incomes of six counties in the Basin were below $3,000. In 1959, all counties had median family incomes below the average for Missouri ($5,127) and also the average for the United States ($5,660). (Map 11) Per capita incomes were correspondingly low, especially in the central counties. Therefore, resource development for the purpose of local and regional economic benefits is a policy consideration in these low-income counties.

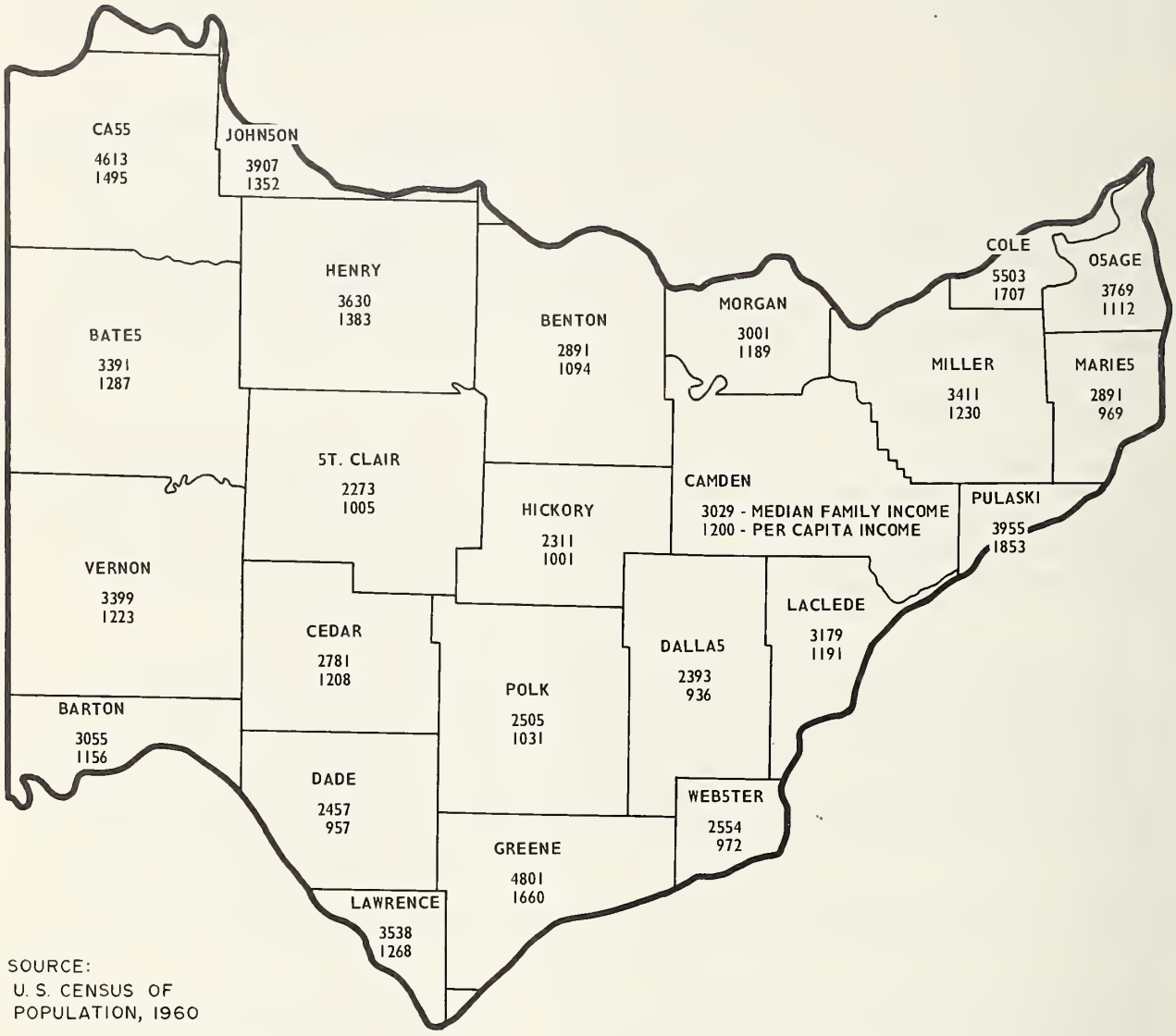
Projected per capita and total personal income for the area are presented in Table 11. These projections were based on regional projections from the Missouri River Basin Comprehensive Study. Per capita income is expected to double the 1959 level by the year 2000. Total personal income is expected to more than double by 1980 and increase by almost five times the 1960 level by the year 2000. The rapid increase in total personal income is predicated on the basis of both higher income levels and increased population.

Table 11. Projected Per Capita and Total Income: South Grand-Osage River Basin, Missouri

Year	Per capita income	Total personal income
	(dollars)	(million dollars)
1959	1,290	327
1980	2,370	740
2000	3,830	1,560
2020	6,210	3,010

Source: Subbasin 8, Missouri River Basin Comprehensive Study.

MAP 11: FAMILY AND PER CAPITA INCOME
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



5. Land Use

Land presently available for agriculture and forestry includes 6,363,600 acres. This land is classified as inventory acreage. The other 517,800 acres are in such uses as urban, roads, and water areas and are classified as non-inventory acreage. The increase in non-inventory and reduction in inventory land were projected and are shown in Table 12. The reduction in land base caused by the construction of Kaysinger and Stockton reservoirs is included in the 1980 projection, since these two projects are now under construction. No other potential reservoirs are considered in these projections. The reduction in land base due to proposed USDA reservoirs is considered later in this report.

Land available for use by agriculture and forestry is expected to decrease by 221,500 acres by 1980. Another 111,400 acres is expected to be taken for nonagricultural uses between 1980 and 2020. Land for new roads and widening existing ones has been considered in the nonagricultural land use projections.

Table 12. Projected Inventory and Non-Inventory Land: South Grand-Osage River Basin, Missouri

Year and Land Resource Area	Non-Inventory 1/	Inventory 2/
	(1,000 acres)	
1968:		
LRA 112	157.4	2,373.6
LRA 116	360.4	3,990.0
Total	517.8	6,363.6
1980:		
LRA 112	318.9	2,212.1
LRA 116	420.4	3,930.0
Total	739.3	6,142.1
2000:		
LRA 112	343.7	2,187.3
LRA 116	443.2	3,907.2
Total	786.9	6,094.5
2020:		
LRA 112	376.9	2,154.1
LRA 116	473.8	3,876.6
Total	850.7	6,030.7

1/ Land areas in urban, roads, and water uses
2/ Land area available for agriculture and forestry.

6. Transportation

Transportation facilities include railroads, truck, bus, and air lines, and a generally adequate road system. The major highways are Missouri 13 from Warrensburg to Springfield, U. S. 71 from Kansas City through Nevada to Carthage, U. S. 65 from Sedalia to Springfield, and U. S. 54 from Nevada to Jefferson City. Interstate Highway 44 follows near the southern border and passes through Springfield; Interstate Highway 70 parallels the northern border. State and county highways serve to connect these major highways.

Important railroads moving freight into and through the Basin are the Missouri-Kansas-Texas, Kansas City Southern, St. Louis-San Francisco, Missouri Pacific, and the Chicago, Rock Island and Pacific. Springfield has the only scheduled airline service. Feeder airlines serve the Lake of the Ozarks. Nearly all counties have adequate truck and bus facilities.

C. Agriculture and Related Economic Activity

1. Land Base for Agriculture

The 2.3 million acres of cropland is the base for agricultural production. Although only 36 percent of the inventoried land is cropland, it is the source of about 70 percent of the agricultural output. Grain crops are produced in 40 percent of the cropland; 39 percent is used for forage crops, and the balance is in other minor crops or idle (Table 13). Forage produced on cropland provides 47 percent of the roughage for livestock.

Table 13. Current Normal Agricultural Land Use and Crop Distribution by Land Resource Areas: South Grand-Osage River Basin, Missouri

Item	LRA 112 Acres	LRA 116 Acres	Total Acres
Cropland:			
Corn for grain	258,100	91,400	349,500
Wheat for grain	120,300	67,300	187,600
Soybeans	151,300	23,200	174,500
Oats	20,700	64,700	85,400
Sorghum	64,400	17,600	82,000
Barley	16,100	20,700	36,800
Total grain crops	630,900	284,900	915,800
Cropland pasture	149,000	290,500	439,500
Hay other than alfalfa	124,000	228,000	352,000
Alfalfa hay	25,800	24,900	50,700
Sorghum silage	21,200	13,500	34,700
Corn silage	15,400	8,800	24,200
Total cropland forage crops	335,400	565,700	901,100
Other crops harvested	15,200	82,100	97,300
Idle cropland	215,300	154,800	370,100
Total Cropland	1,196,800	1,087,500	2,284,300
Non-Cropland:			
Permanent pasture	578,900	916,200	1,495,100
Grazed forest land	360,600	729,100	1,089,700
Non-grazed forest land	66,600	1,168,900	1,235,500
Other land	170,700	88,300	259,000
Total Non-cropland	1,176,800	2,902,500	4,079,300
Total Land	2,373,600	3,990,000	6,363,600

The 1.5 million acres of permanent pasture is the grazing base for the extensive livestock production; it provides 46 percent of the forage needs. In contrast, the 1.1 million acres of lower-producing, grazed forest land provides only seven percent of the forage.

Although almost as much cropland is found in Land Resource Area 116 as in LRA 112, more than twice the acreage is devoted to cultivated crops in the latter area. The steep, rough topography with scattered and broken fields of cropland in LRA 116 is not conducive to machinery operations.

About 5 million of the 6.4 million acres available for producing agricultural and forestry products are used by about 23,000 farmers. This farmland decreased by about 400,000 acres from 1950 to 1964. The decrease in acreage primarily occurred in forest land and permanent pasture.

2. Agricultural Characteristics

Only 61 percent of the farms are commercial farms with a value of sales of $2,500 or more per farm, compared to 65 percent for the State of Missouri and 68 percent for the United States. The rest are either part-time (23 percent) or part-retirement (16 percent) operations. Commercial farmers manage 83 percent of the farm land. The large number of part-time operators are further reflected by the fact that 48 percent of the farmers worked off their farms and 34 percent worked 100 days or more off their farms in 1964.

Some of the trends taking place in agriculture are illustrated in Table 14. The number of farms is rapidly decreasing; average size of farms is increasing as is farm investment. These trends are consistent with national trends and reflect the rapid adoption of technology and the replacement of labor with capital. The average farm size in 1964 was about 220 acres, and the average investment in land and buildings was $123 per acre.

Table 14. Trends in Farm Characteristics, 16 Major Counties: South Grand-Osage River Basin, Missouri

Item	Unit	Year		
		1949	1959	1964
Number of farms	No.	35,003	25,956	23,338
Number of commercial farms	No.	24,645	15,185	14,242
Average size of farms	Acres	159	200	220
Value of land and buildings	Mil. dol.	269	449	631
Average value of land and buildings per acre	Dollars	48	86	123

Source: 1964 Census of Agriculture

3. Volume and Value of Farm Output

Current normal production and gross value of major crops and livestock products are shown in Table 15. Current normal production and values represent the recent base production and prices adjusted to eliminate any abnormalities due to fluctuations caused by unusual conditions.

Table 15. Current Normal Agricultural Production and Gross Value: South Grand-Osage River Basin, Missouri

	Production	Price per unit 2/ (dollars)	Value of production (1000 dollars)
Cash Crops:			
Soybeans	3,700,000 bu.	2.43 per bu.	8,991
Wheat	4,801,000 bu.	1.24 per bu.	5,953
Other crops	--	--	1,400
Total			$16,344
Feed Grains:			
Corn	16,217,000 bu.	1.11 per bu.	18,001
Sorghum	3,682,000 bu.	1.01 per bu.	3,719
Oats	2,845,000 bu.	.63 per bu.	1,792
Barley	1,089,000 bu.	.84 per bu.	915
Total			$24,427
Roughage Crops:			
Permanent pasture	1,286 mil.FU 1/	1.92 per 100	24,691
Cropland pasture	646 " "	" " "	12,403
Hay other than alfalfa	352 " "	" " "	6,758
Grazed forest	185 " "	" " "	3,552
Alfalfa hay	141 " "	" " "	2,707
Sorghum silage	110 " "	" " "	2,112
Corn silage	78 " "	" " "	1,498
Total	2,798 mil.FU		$53,721
Livestock Products:			
Cattle and calves	221,580,000 lbs.	22.52 per Cwt.	49,900
Milk	650,730,000 lbs.	3.65 per Cwt.	23,752
Hogs and pigs	114,110,000 lbs.	15.05 per Cwt.	17,174
Eggs	13,455,000 doz.	.28 per doz.	3,767
Turkeys	16,960,000 lbs.	.19 per lb.	3,222
Broilers	13,730,000 lbs.	.14 per lb.	1,922
Sheep and lambs	5,620,000 lbs.	18.18 per Cwt.	1,022
Other livestock products	--	--	200
Total			$100,959
Gross Value			$195,451
Net gross value			$129,765

1/ The basic feed unit is the feed value of one pound of number 2 yellow corn or its equivalent.
2/ Price Base, Adjusted Normalized Prices, April 1966

The gross value of all crops raised is estimated at about $94.5 million dollars. The crop values represent the value of production if all crops could be sold at their current normal values. The value of roughage crops, based on a hay value of $21.12 per ton, is estimated at $1.92 per feed unit. Although the gross values derived for pasture crops are hypothetical, they provide a method of comparing the relative values of the various crops.

Forage crops account for 57 percent of the gross crop value. Permanent pasture and cropland pasture are the two major sources of forage accounting for almost 40 percent of the value of crops. Cash crops account for 17 percent of the gross value of crops and feed grains for 26 percent. Corn is the major field crop produced, providing 13 percent of the gross value of crops.

The gross value of livestock produced is 101 million dollars. Beef is the major type of livestock raised, accounting for about half of the gross value of livestock products. Milk, second in importance, and hogs, third in importance, provide about 24 and 17 percent respectively of the value of livestock products. Eggs, turkeys, broilers, sheep and other livestock products account for the remainder.

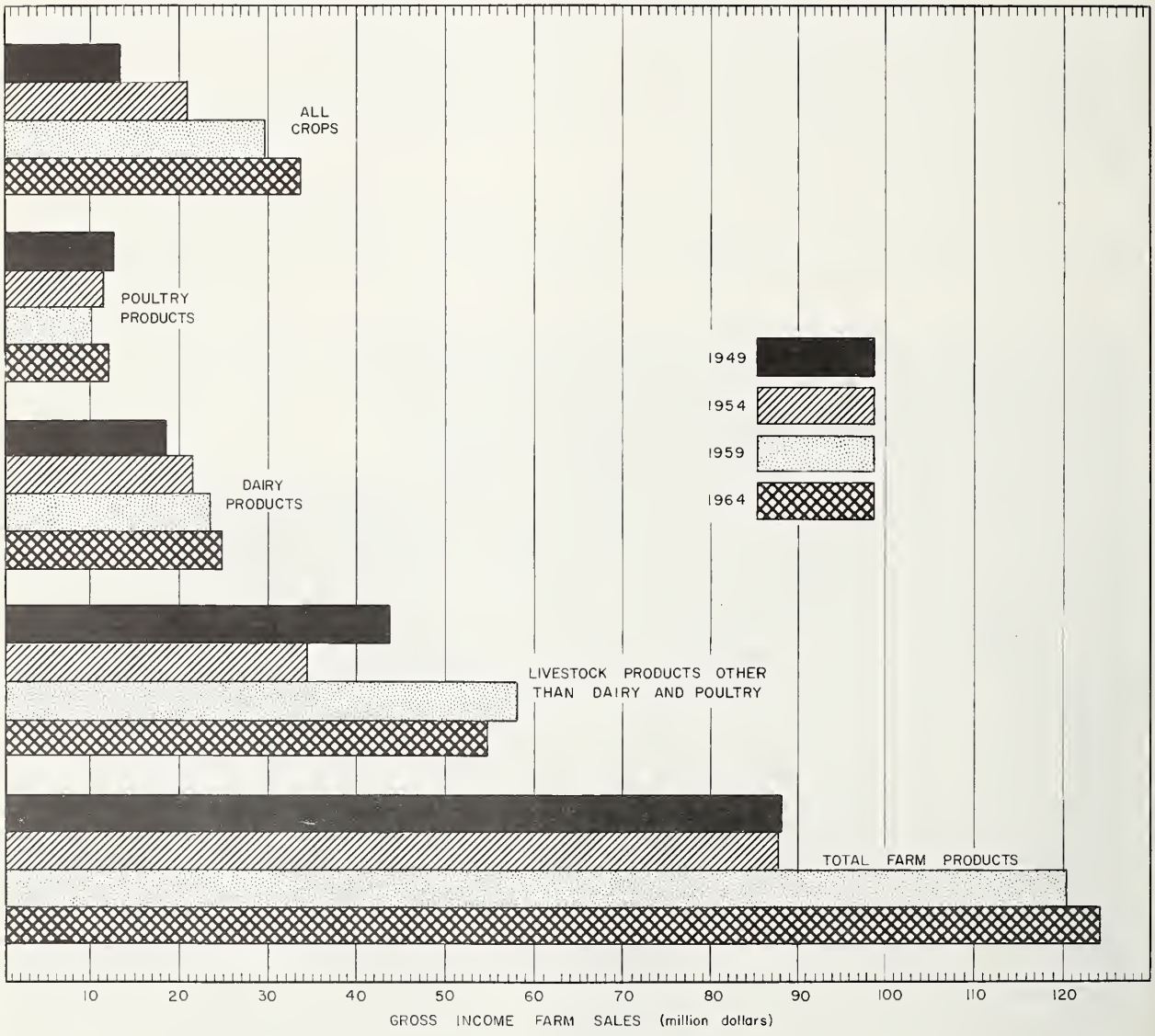
Feed grain crops are considered as cash crops by many farmers. However, it is estimated that all feed grains produced are needed for livestock feed in the Basin and thus, there are no net exports. It is estimated that only

Feed grain and livestock are the most important agricultural enterprises.

77 percent of the roughage produced is needed for livestock feed. The net gross value of production from all crops and livestock after adjustment for feed consumed by livestock is about 130 million dollars. This closely approximates other estimates of the value of crops and livestock sold from the area.

Trends in the value of production for the 16 major counties are presented in Figure 6. The value of both crops and dairy products has been increasing since 1949. The value of other livestock products (beef and hogs) has fluctuated but shows an increasing trend, while the value of poultry products shows no particular trend.

FIGURE 6: TRENDS IN VALUE OF FARM PRODUCTS SOLD IN 16 MAJOR COUNTIES
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



4. Farm Costs

Purchases of farm supplies and services for agricultural production contributes significantly to the economy of the area. Although lack of data does not permit a complete tabulation of farm expenses, some of the major ones are presented in Table 16.

Table 16. Selected Farm Costs 1/: South Grand-Osage River Basin, Missouri

Item	1,000 dollars
Feed purchased	30,107
Livestock and poultry purchased	16,653
Gasoline and other fuels & oils	7,303
Fertilizer	6,366
Hired labor	4,159
Machine hire	3,602
Seed, bulbs, and plants purchase	2,527

1/ Source: 1964 Census of Agriculture except fertilizer cost which was estimated on the basis of data collected.

5. Future Agricultural Requirements

Projected estimates of demand for the various agricultural products provided one framework for analyzing water resource development projects. National and regional projection of demand for agricultural products was made in the Missouri Type I Study for the years 1980, 2000, and 2020.

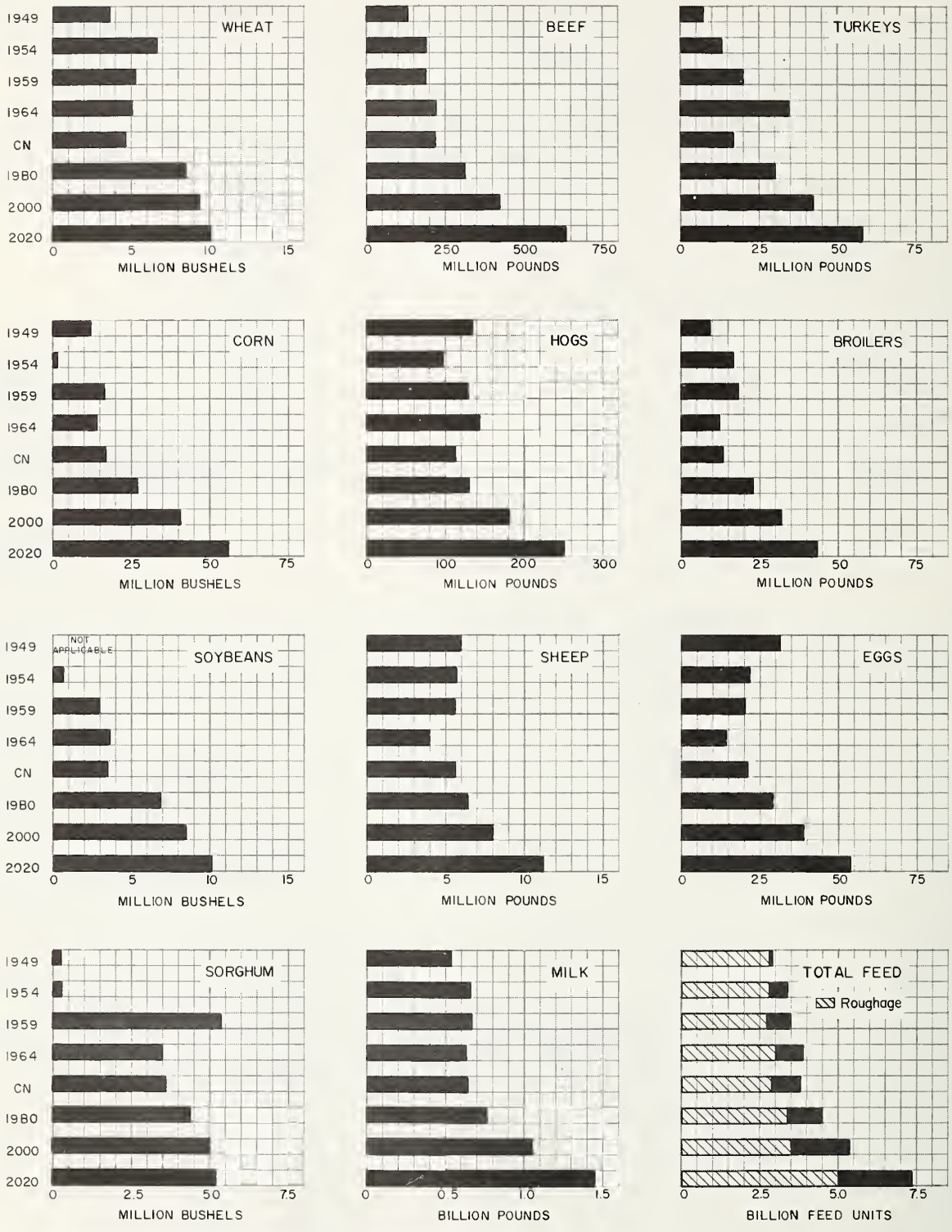
The major forces considered in these projections include: population growth, rising per capita disposable income, changes in consumer tastes and their influence on per capita consumption, industrial and other uses of agricultural commodities, exports and imports. Future requirements for agricultural products in the Basin were based on past trends in relation to the larger Subregion 8 of the Missouri River Basin Comprehensive Study.

Trends in production and projected requirements for the major field crops are shown in Figure 7. Wheat production is expected to almost double by 1980 and then increase at a slower rate. Corn, the most important feed grain, is expected to continue its rapid increase in production throughout the projection period. Soybean production is currently five times the 1954 level and is expected to double by the year 1980. Sorghum output will increase but at a slower rate. Production of other less important crops was projected in a similar manner.

Projections of requirements for forage crops are based on the needs of feed for livestock. Thus, it was necessary to project future livestock production before roughage feed needs could be estimated. Trends in production and projected demand for livestock products are shown in Figure 7.

The share of beef production is expected to remain at about 20 percent of Subregion 8, while actual production almost doubles by the year 2000.

FIGURE 7: HISTORICAL AND PROJECTED PRODUCTION FOR MAJOR FIELD CROPS, LIVESTOCK AND POULTRY, AND ROUGHAGE AND TOTAL FEED REQUIREMENTS SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



CN = CURRENT NORMAL, 1959-1963 5-YEAR AVERAGE

Pork production will increase slightly; sheep and lamb production is projected to increase 50 percent by the year 2000. Milk production is expected to more than double by 2020. Turkey and broiler production is expected to continue to increase, and the downward trend in egg production is projected to reverse.

Feed requirements for livestock and poultry are a function of the animal products produced and the efficiency of the animals in converting feed into the product. Present and future feed requirement estimates per pound of product were made by agricultural specialists at the University of Missouri. The basic feed unit used is the feed value of one pound of number 2 yellow corn or its equivalent with .8 pound of total digestible nutrients. The composition of rations for each type of livestock or poultry producing unit was estimated also, and historical and future needs for livestock feed were determined.

The historical and projected relationship between total feed needs for livestock and roughage requirements is illustrated in Figure 7.

Current normal feed needs for livestock and poultry are shown in Table 17. The 1,223 million grain feed units needed for livestock feed is almost equal to the grain produced. Thus, there is no net export of feed grains.

Table 17. Current Normal Feed Requirements for Livestock and Poultry: South Grand-Osage River Basin, Missouri

Type of Livestock	Current Normal Feed Requirements 1/		
	Grain	Roughage	Other
	Million feed units 1/		
Beef and veal	443	1,551	222
Pork	407	14	57
Sheep and lambs	10	54	3
Milk	252	529	32
Eggs	53	0	23
Broilers	22	0	14
Turkeys	36	0	30
TOTAL	1,223	2,148	381

1/ The basic feed unit is the feed value of one pound of number 2 yellow corn or its equivalent.

Current normal roughage feed needs for livestock and poultry are estimated at about 2,148 million feed units. This is only about 77 percent of the estimated current normal production. Hay is either being shipped out or pasture forage is not being utilized as efficiently as estimated. Another possibility is that forage crops are being used more extensively and feed grains less extensively than estimated, in which case there may be a net export of feed grains. For the purpose of analysis, it was assumed that all feed grains were used and a surplus of about 23 percent of roughage crops beyond livestock needs will continue to be produced.

6. Current Normal and Projected Yields

Future production is a function of not only the acreage in the crop but the yields. Crop yields have increased in the past and are expected to continue to increase as new technology and better management techniques are developed and adopted. The current normal yields and projected rates of increase are presented in Table 18.

Table 18. Indices of Projected Yields: South Grand-Osage River Basin, Missouri 1/

Crop	Current Normal Yields	Index of Yield 2/ Year 1980	2000	2020
Wheat grain	25.6 bu.	138	166	191
Corn grain	46.4 bu.	142	170	194
Corn silage	3,200 F.U. 3/	142	170	187
Sorghum grain	44.9 bu.	133	160	184
Sorghum silage	31.7 bu.	133	152	166
Oats grain	33.3 bu.	138	159	175
Barley grain	29.6 bu.	142	166	187
Alfalfa hay	2,780 F.U.	137	159	176
Other hay	1,000 F.U.	147	168	181
Soybeans	21.2 bu.	127	141	148
Cropland pasture	1,470 F.U.	135	155	167
Permanent pasture	860 F.U.	140	161	171
Grazed forest land	170 F.U.	121	128	133

1/ Adapted from Missouri River Basin Comprehensive Study.
2/ Current Normal = 100; Yields = Index Number/100 x current normal.
3/ Feed Units: The basic feed unit is the feed value of one pound of number 2 yellow corn or its equivalent.

D. Forest Resources and Related Economic Activity

Area

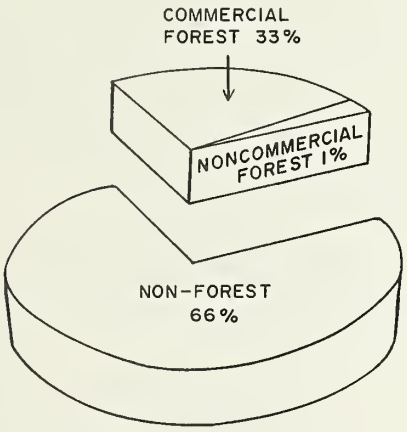
Forest is one of the major land uses in the Basin. Approximately 2.3 million acres (34 percent) of the land is forested 1/(Figure 8 and Table 19).

Table 19. Area of Forest Land by LRA, 1959: South Grand-Osage River Basin, Missouri

LRA	Total Land	Total Forest	Commercial Forest	Non-commercial Forest
		(thousand acres)		
112	2,664.1	427.2	424.3	2.9
116	4,217.3	1,898.0	1,814.6	83.4
Basin Total	6,881.4	2,325.2	2,238.9	86.3

1/ Technical Report No. 2 Forest Resources in the South Grand-Osage River Basin contains more detailed information and discussion of the forest resource and its contributions to the Basin.

FIGURE 8: FOREST LAND, 1959:
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI

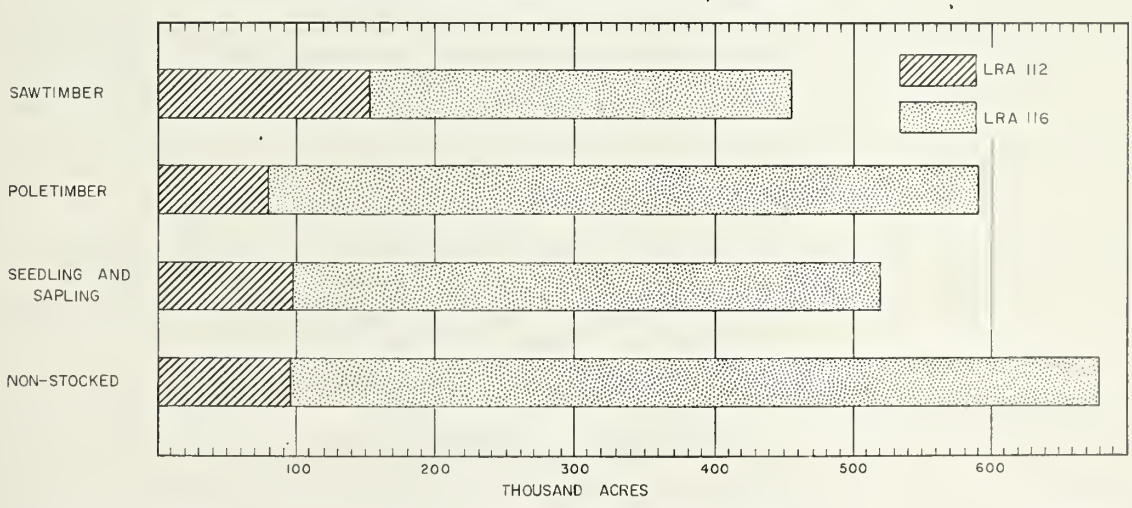


Ninety-six percent of this area is classified as commercial forest land, i.e., land which is either producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization. The remainder is classified as non-commercial forest land--either unsuitable for timber growing because of low productivity or because of legal reservations for recreation and other non-timber uses.

About 82 percent of the commercial forest land is found in the Ozark Highland, LRA 116. The balance is in the Cherokee Prairies, LRA 112.

Almost 30 percent of the Basin's commercial forest land is classed as non-stocked, Figure 9. This includes idle farm land reverting to forest but still in the brush transition stage and stands of trees that are too poor in quality for growing stock because of fire damage or other abuse.

FIGURE 9: COMMERCIAL FOREST AREA BY STAND-SIZE CLASS, 1959
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Approximately 29 percent of the remaining forest area is in sawtimber sized stands, 38 percent in poletimber stands, and 33 percent in seedling and sapling stands. Almost 45 percent of the 519,000 acres in the latter category is poorly stocked.

Twenty percent (94,600 acres) of the commercial forest land in LRA 112 is classed as non-stocked. In LRA 116, the non-stocked area is 32 percent or 581,600 acres. Almost 16 percent (28,900 acres) of the seedling and sapling stands in LRA 112 is poorly stocked compared to 49 percent (207,700 acres) in

LRA 116. The relationship between areas with pole and sawtimber stands is almost the reverse of this. The Cherokee Prairies has a greater proportion of standing timber in the sawtimber class than does the Ozark Highland.

Hardwood types predominate in the Basin's forests (Table 20). Softwood types, which include shortleaf pine and eastern red cedar occur on approximately 6,500 acres of commercial forest land. Upland oak types occupy 37 percent of the forested land and 30 percent is in the post-black jack oak type.

Table 20. Area of Commercial Forest Land by Land Resource Area and Type, 1959 1/: South Grand-Osage River Basin, Missouri

Type	LRA 112	LRA 116	Total
		(Thousand Acres)	
Pine	.4	6.1	6.5
Red cedar	7.5	3.9	11.4
Hardwood red cedar	7.5	65.3	72.8
Oak-pine	-	3.3	3.3
Black-scarlet oak	144.5	689.9	834.4
White oak	31.2	214.5	245.7
Post black jack oak	90.3	583.3	673.6
Elm-ash-cottonwood	142.9	248.3	391.2
Total of Types	424.3	1,814.6	2,238.9

1/ Source of basic data - North Central Forest Experiment Station, St. Paul, Minnesota.

The management of forest land and the availability of timber depend greatly on the decisions of the farmer and miscellaneous private owners who hold over 99 percent of the Basin's commercial forest land (Table 21).

State ownership, concentrated in LRA 116, is less than one percent. The privately owned tracts are generally under 100 acres in size.

Table 21. Area of Commercial Forest by Land Resource Area and Ownership, 1959: South Grand-Osage River Basin, Missouri

LRA	Commercial Forest Area by Ownership			
	Total	State	Farmer Owned	Other Private
		(Thousand Acres)		
112	424.3	-	315.4	108.9
116	1,814.6	4.1	1,392.9	417.6
Total	2,238.9	4.1	1,708.3	526.5

Source: North Central Forest Experiment Station, St. Paul, Minnesota.

More than half of the private ownership changed hands from two to nine times in the last ten years. The majority of these forest landowners are engaged in occupations or enterprises not directly connected with timber production.

Volume

The forests of the Basin support over 528 million cubic feet of growing stock timber volume 1/. This volume is predominantly in hardwood species; softwoods represent less than one percent of the total (Table 22).

Table 22. Volume of Growing Stock by Land Resource Area, Owner, Species Group and Size, 1952 1/
South Grand-Osage River Basin, Missouri

L. R. A.	All Sizes					Pole Timber Size					Saw Timber Size				
	All Species	Hardwoods			Soft Woods	All Species	Hardwoods			Soft Woods	All Species	Hardwoods			Soft Woods
		All	Hard	Soft			All	Hard	Soft			All	Hard	Soft	
	(Million cubic feet)														
112															
Ownership															
State	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Farmer owned	81.9	81.8	62.6	19.2	.1	41.8	41.7	33.5	8.2	.1	40.1	40.1	29.1	11.0	2/
Other private	28.3	28.2	23.5	4.7	.1	14.3	14.2	13.3	.9	.1	14.0	14.0	10.2	3.8	2/
All ownerships	110.2	110.0	86.1	23.9	.2	56.1	55.9	46.8	9.1	.2	54.1	54.1	39.3	14.8	2/
116															
Ownership															
State	16.0	14.2	12.7	1.5	1.8	9.7	8.2	7.6	.6	1.5	6.3	6.0	5.1	.9	.3
Farmer owned	321.3	321.1	290.3	30.8	.2	194.2	194.0	180.4	13.6	.2	127.1	127.1	110.0	17.1	-
Other private	81.3	80.9	73.2	7.7	.4	49.0	48.7	45.3	3.4	.3	32.3	32.2	27.8	4.4	.1
All ownerships	418.6	416.2	376.2	40.0	2.4	252.9	250.9	233.3	17.6	2.0	165.7	165.3	142.9	22.4	.4
Basin															
Ownership															
State	16.0	14.2	12.7	1.5	1.8	9.7	8.2	7.6	.6	1.5	6.3	6.0	5.1	.9	.3
Farmer owned	403.2	402.9	352.9	50.0	.3	236.0	235.7	213.9	21.8	.3	167.2	167.2	139.1	28.1	2/
Other private	109.6	109.1	96.7	12.4	.5	63.3	62.9	58.6	4.3	.4	46.3	46.2	38.0	8.2	.1
All ownerships	528.8	526.2	462.3	63.9	2.6	309.0	306.8	280.1	26.7	2.2	219.8	219.4	182.2	37.2	.4

1/ Source of basic data - North Central Forest Experiment Station, St. Paul, Minnesota.

2/ Insignificant amount.

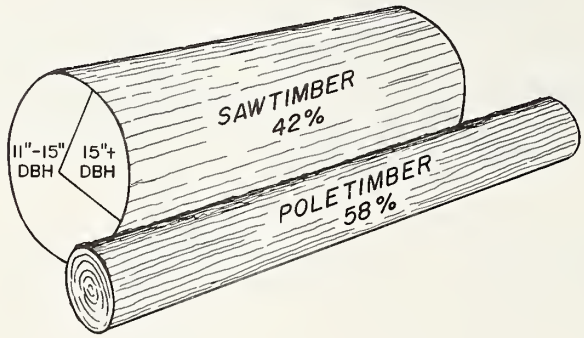
With the exception of the three percent occurring in State ownership, all the commercial volume is found on privately owned forest land.

Basin-wide, the bulk of the growing stock volume is in the hardwood species group (Table 22). A little over 526 million cubic feet is in this group. Eighty-eight percent of this volume consists of premium hardwoods such as white oak, black oak, and black walnut. These are currently in high demand for barrel stave, veneer, furniture, and gunstock manufacture. The remaining 12 percent of the hardwood volume is in other hardwoods, which include soft maple, cottonwood, willow, sycamore, and elm. In the softwood species group, 2.6 million cubic feet of growing stock volume is comprised of shortleaf pine and eastern red cedar.

1/ Volume of sound wood in merchantable trees.

Approximately 58 percent of the Basin volume (306.8 million cubic feet) is in poletimber 1/; the remaining volume occurs in saw timber trees 2/ (Figure 10).

FIGURE 10: DISTRIBUTION OF CUBIC FOOT VOLUME BY KIND OF MATERIAL AND SIZE CLASS, 1959: SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Forty-four percent of the sawtimber volume (219.8 million cubic feet) is in the 15" + diameter class, the class in which the highest quality logs are usually found (Table 23).

Table 23. Distribution of Sawtimber Cubic Foot Volume by Land Resource Area and Diameter Class, 1959:* South Grand-Osage River Basin, Missouri

LRA	Size 11" - 15"	Size 15" +	Total Saw Volume
		(millions)	
112	25.6	28.5	54.1
116	96.5	69.2	165.7
Total	122.1	97.7	219.8

* Source of basic data - North Central Forest Experiment Station, St. Paul, Minnesota.

Fifty-three percent (28.5 million cubic feet) of the sawtimber volume is in the 15" + diameter class in LRA 112, while only 44 percent of LRA 116's saw volume is in this size. The remaining sawtimber volume is in the 11"-15" diameter class. Quality in the Basin is low. Only 17 percent (38 million cubic feet) of the saw log material is large enough and sufficiently

1/ Poletimber trees - trees of softwood species between 5.0" and 8.9" d.b.h. and hardwoods 5.0" to 10.9" d.b.h.
2/ Sawtimber trees - line merchantable softwoods 9.0" d.b.h. and greater and hardwoods 11.0" and greater.

defect-free to qualify as log grade 2 or better 1/. Thirty-one percent (67 million cubic feet) is in log grade 3, and an overwhelming 52 percent (115 million cubic feet) is in tie and timber grade (Table 24). The distribution of volume by log grade is roughly equal in both areas.

Table 24. Volume of Growing Stock Sawtimber Material by Land Resource Area and Log Grade, 1959:* South Grand-Osage River Basin, Missouri

LRA	Grade 2 and Better	Grade 3	Tie and Timber	All Grades
		(Million Cubic Feet)		
112	9.4	16.5	28.2	54.1
116	28.6	50.7	86.4	165.7
Basin Total	38.0	67.2	114.6	219.8
Percent	(17)	(31)	(52)	

* Source of basic data - North Central Forest Experiment Station, St. Paul, Minnesota.

The Basin's growing stock volume is increasing at an average annual rate of 28.6 million cubic feet or 5.4 percent, before allowing for cut (Table 25). This equals approximately 12.5 cubic feet per acre annually.

Table 25. Timber Cut, Growth, and Inventory of Growing Stock on Commercial Forest Land in 1962 and Projections 1980-2020: South Grand-Osage River Basin, Missouri

Year	Cut			Growth			Inventory		
	All Species	Soft-woods	Hard-woods	All Species	Soft-woods	Hard-woods	All Species	Soft-woods	Hard-woods
				(Million Cubic Feet)					
1962	9.8	*	9.8	28.6	.2	28.4	528.8	2.6	526.2
1980	14.8	*	14.8	47.7	.2	47.5	883.1	2.8	880.3
2000	25.1	.1	25.0	65.3	.3	65.0	1,209.8	3.0	1,206.8
2020	39.4	.1	39.3	76.3	.3	76.0	1,572.7	3.3	1,569.4

* Insignificant amount.

The net annual cut in the Basin is roughly one-third of the growth (Table 25). This removal of growing stock material centers in the hardwood species group; the cut of softwoods is negligible.

Projections indicate a steady increase in growth and cut in the Basin. As shown in Table 25, 1980 growth will be a little less than double the 1962

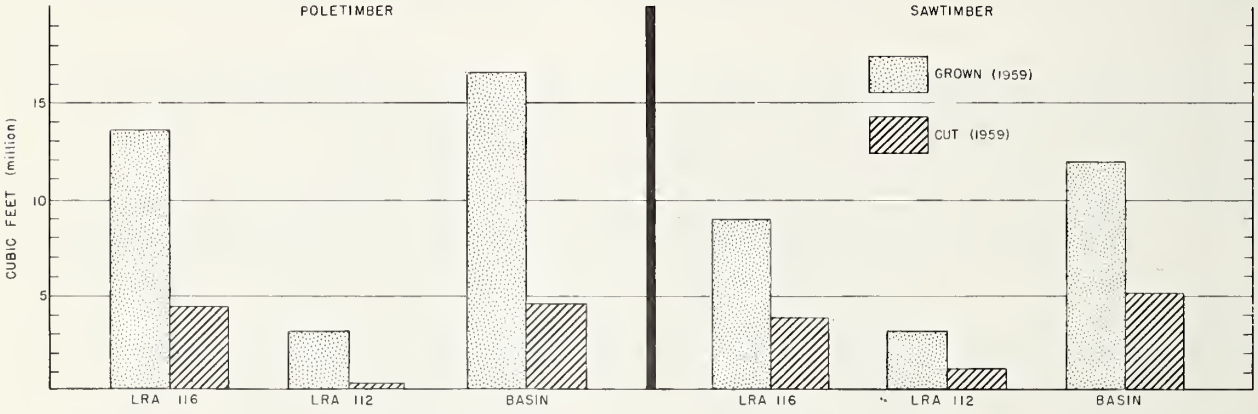
1/ Log grades based on the hardwood log grades for standard lumber developed by the Forest Products Laboratory. In grading, the tree was divided into 16-foot lengths where possible and the best 12-foot portion of each section was graded.

figure and by 2020 will almost triple. Growth increases reflect an increase in utilization of growing space. As the inventory volume is built up, the net growth volume will increase. The rate of growth, however, will drop from the present 5.4 percent to 5.0 percent in 2020.

The net annual cut is projected to increase to 14.8 million cubic feet by 1980, and a four-fold increase is projected by 2020. More significant than this increase is the proportion of the net annual growth which will be harvested. Amounting to only 34 percent of the growth in 1962, cut will increase to approximately 52 percent of the growth by 2020, indicating increased utilization of the Basin's forest resources.

The net annual cut is almost evenly distributed between pole and sawtimber material indicating a demand for small-sized stock. Almost 86 percent (8.4 million cubic feet) comes from Land Resource Area 116 (Figure 11).

FIGURE 11: NET ANNUAL GROWTH AND CUT OF GROWING STOCK ON COMMERCIAL FOREST LAND SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



Currently, there are about 85 active wood-using establishments in the Basin (Table 26). Included in this number are some 44 sawmills, 17 charcoal plants, and five stave mills engaged in primary manufacture. The volume of

Table 26. Estimated Annual Value of Payrolls, Manufacturing and New Capital Expenditures in Lumber and Wood Products Industries, 1962 1/: South Grand-Osage River Basin, Missouri

Industry Group	Establishments Number	Payroll Dollars	Value Added By Manufacture Dollars	Capital Expenditures Dollars
Sawmills	44	809,856	1,322,514	146,432
Other 2/	41	1,974,626	3,054,688	187,703
Total	85	2,784,482	4,377,202	334,135

1/ From Bureau of Census data.
2/ Stave mills, furniture plants, flooring mills, pallet plants, novelty plants, charcoal plants, wood treating plants, and gunstock plants.

wood used for lumber and cooperage logs has remained fairly constant since 1952. The number of charcoal plants has increased since then.

Lumber and wood products industries in the Basin spend an estimated 334 thousand dollars annually for capital improvements. This is about eight percent of the added value of manufacture, while their total payroll is estimated at 64 percent of the value or 2.8 million dollars (Table 26).

The lumber industry is the backbone of the forest economy. In addition to its use in construction, lumber is marketed to larger secondary manufacturers to produce flooring, furniture, and pallets. An estimated 4.4 million dollars of value is added annually through the secondary manufacture of lumber products of Basin origin (Table 26).

The total annual timber products output[1/] is around 12.0 million cubic feet (Table 27) of which the output of saw logs is about 18 percent. Fuelwood and charcoal production accounts for 65 percent (7.2 million cubic feet) of the total Basin output. Forty-five percent of this is from charcoal production. The balance of total output is made up of veneer logs, fence posts, cooperage logs, and other industrial products. Practically all this output was produced from hardwood timber. The total value of this output is 2.8 million dollars.

Table 27. Primary Timber Products Output in 1952 and 1962, and Projections 1980, 2000, and 2020: South Grand-Osage River Basin, Missouri

Year	Total Output	Saw Logs	Veneer Logs	Cooperage Logs	Charcoal Wood	Fuel Wood	Fence Posts	All Other Wood Products[1/]
				(Thousand Cubic Feet)				
1952	12,606.5	2,200.0	86.9	323.9	742.6	6,738.7	1,350.9	1,200.8
1962	12,000.1	2,148.5	63.2	158.0	3,476.0	4,273.9	576.7	1,303.5
				Projections 2/				
1980	13,904.0	3,547.1	79.0	102.7	4,858.5	2,733.4	371.3	2,212.0
2000	18,170.0	4,834.8	102.7	71.1	6,849.3	2,006.6	268.6	4,036.9
2020	24,885.0	6,446.4	110.6	63.2	9,638.0	1,627.4	221.2	6,778.2

1/ Turnery bolts, poles, piling, box bolts and a miscellaneous assortment of similar items.

2/ From Missouri River Framework Study and other sources.

Although less wood fiber is used for lumber than for fuelwood and charcoal, lumber logs must be considered the most important forest product because they have higher value and they account for the largest drain on the growing stock. About 72 percent of the lumber log output comes from growing stock timber, while most of the wood used for fuelwood and charcoal comes from non-growing stock sources such as limb wood, dead and cull trees, and plant by-products.

1/ Timber output is the amount of raw material received at the mill as reported by mill receipts.

Photo by: Owens Missouri Commerce and Industrial Development

From boards to gunstocks - a wide range in forest products.

Lumber output is affected by national lumber consumption and is generally related to activity in industries like housing and fabricated products. Based on predicted activity in these industries estimated by the Missouri River Basin Type I Study, saw log output is expected to be increased by two-thirds in 1980 and triple by the year 2020.

The total annual production of all wood products is expected to increase to about 24.9 million cubic feet (Table 27) by 2020. The output of saw logs will account for as much as 26 percent of this, while fuelwood and charcoal is expected to decline to 45 percent of the total output. The proportion of charcoal produced is expected to account for 86 percent of this category by 2020.

An estimated 1,650 persons are employed in timber-based manufacturing. Of these, timber harvesting employs 560 persons. Employment in lumber and wood products included 342 persons employed in sawmills and 748 in other wood-producing establishments i.e., stave mills, furniture plants, flooring mills, pallet 1/ plants, novelty plants, charcoal plants, wood treating plants, and gunstock plants (Table 28).

Overall, employment has declined since 1952 because of the increased efficiency of harvesting operations and low wages. Employment in sawmills and other wood-producing establishments has remained fairly steady. With the decline in timber harvesting, undoubtedly, these wood-producing industries made greater use of timber suppliers operating outside the Basin.

Greater demand and higher prices for standing timber, coupled with less rigid product specifications and better utilization, will eventually increase the profitability of timber harvesting. By 1980, it is estimated that the number of persons employed in timber harvesting will increase to 896. An additional increase to 1,477 is anticipated by 2020 (Table 28).

Employment in lumber and wood products manufacturing is expected to continue to experience steady increases to keep pace with national demands. An increase in employment of 30 percent is expected by 1980. An increase of over 80 percent by 2020 will result in 1,681 persons working in the manufacturing of lumber and wood products.

The production of veneer logs is expected to increase. The use of container veneer will decrease as substitute materials such as fiberboard and plastic claim larger shares of the market. This reduction will probably be offset by increases in the use of face and commercial veneer for paneling, furniture, stock and novelty items.

The charcoal industry, which has boomed in recent years, will probably continue to expand to help satisfy the growing needs of the Nation's outdoor chefs. It is estimated that about half of the charcoal produced is used in industry and for a variety of miscellaneous purposes such as tobacco curing and water purification. Forest resources and labor are available to produce

1/ A pallet is a small platform used for storage of goods designed to reduce labor and handling costs of merchandise in warehouses and transit in trucks, trains, and ships.

Table 28. Estimated Employment in Timber Based Manufacturing Industries in 1952 and 1962, and Projections 1980, 2000 and 2020: South Grand-Osage River Basin, Missouri

Year	Grand Total	Lumber and Wood Products[1/]			Timber[2/] Harvesting
		Total	Sawmills	Other	
			(Number)[3/]		
1952	1,787	834	340	494	953
1962	1,650	1,090	342	748	560
			PROJECTIONS[4/]		
1980	2,101	1,205	513	692	896
2000	2,572	1,435	641	794	1,137
2020	3,158	1,681	784	897	1,477

1/ Includes logging camps engaged in cutting timber, sawmills (all sizes), cooperage stock mills: and establishments engaged in manufacturing finished articles made entirely or mainly of wood (Major group 24 as defined by the Bureau of the Census).

2/ Includes employment and payrolls not accounted for in the "Census of Manufactures Reports" by the Bureau of the Census. An estimate of employment involved in the harvesting of rough fuelwood and minor industrial products from forest to delivery of logs by truck to mill or F.O.B.

3/ From Bureau of Census Data.

4/ From Missouri River Framework Study. Includes operators listed in transportation but previously engaged in harvesting and seasonal workers.

charcoal to help meet the growing demand. The supply of wood for charcoal is both plentiful and readily available. Plants that are now producing far below their capacity will be able to increase their operations by replacing the traditional slow-burning kilns with continuous steel retorts capable of producing a load of charcoal in a few hours.

It is anticipated that pallet manufacture will become a more important industry in the Basin. Presently, there is only one full-time wooden pallet manufacturer in the Basin. There is an abundant supply of wood for this industry, which can utilize low-grade, small-size logs.

More than 90 percent of the cooperage bolts produced today are manufactured into liquid-tight containers, primarily bourban barrels. Future demand for cooperage is difficult to forecast; however, if existing Federal regulations were changed to allow the reuse of bourbon barrels, the demand for tight cooperage could be significantly reduced. Production of slack

cooperage for shipping has declined in recent years because of competion from the paperboard containers industry. The decline is expected to continue.

The production of fuelwood and wooden fence posts also has been decreasing steadily in recent years and will continue downward. In the past, wood provided most of the industrial and domestic fuel needs; but it has rapidly given way to more convenient and better types of fuel. Fuelwood is still important in the Basin where it accounts for half of the total output of timber products. Fuelwood is fast becoming a luxury item used primarily in residential fireplaces. Fence-post production should continue to drop as farms become fewer and larger and improved treating methods lengthen the life of wooden fence posts.

New pulpwood markets for the Ozarks, within the economic proximity of the Basin, seem likely within the projection period. Consumption of hardwood pulpwood has been increasing for some years, and increasing national use of hardwood for pulp is forecast for the future. The strong interest in Missouri as a pulpwood producing area stems from an ample wood and water supply, nearness to large markets, and low labor and land costs. Projection of pulpwood output and water use is not included in this report because of the uncertainties of mill locations. Increased overall expansion of lumber and wood products industries should result in even greater expenditures for labor and capital, roughly in proportion to the predicted increases in output for 1980-2020.

Markets exist for other forest products produced in the Basin. Close proximity to several rather large metropolitan areas provides excellent opportunity for Christmas tree production and marketing. Several highly successful enterprises located near the Basin are currently supplying a portion of the needs. Local operations could compete favorably and gain a share of this lucrative market.

Walnut receipts over the last ten-year period totaled 47.6 million pounds. At the current value of $4 per hundred pounds of hulled walnuts, these nuts brought the producers $1,904,088 or an average of a little over $190 thousand per year. Most of this production is from trees growing in the wild and is appreciably lower than what could be produced in a plantation-type environment. Walnut buyers with facilities for collecting and hulling the nuts are located throughout the Basin. A highly successful walnut processing and marketing plant is located in Stockton, Missouri.

The pecan market is also very strong and is favorable for expansion. The present pecan supply originates from plantations. The current price is 40 cents per pound for cracked nuts.

E. Outdoor Recreation and Related Economic Activity

Recreation is an important use of water and related land resources and an important segment of the economy in the area. The streams, lakes, and rolling wooded topography are suitable to several types of recreational facilities. Three State Parks -- Lake of the Ozarks, Bennett Springs, and Pomme de Terre are located in the Basin.

Lake of the Ozarks State Park, located on the Grand Glaize Arm of the Lake, is the largest in the Missouri State Park system containing 16,335 acres. Attendance has been increasing steadily from 206,060 in 1958 to 680,670 in 1968, or a 230 percent increase. Income from the State Park facilities has increased nearly 200 percent during this period.

Bennett Springs State Park, located 12 miles west of Lebanon on the Niangua River, features a clear stream fed by a large spring. Its popularity is derived from the put and take fishery operated by the Department of Conservation. This park has always been one of the favored recreational areas in the Basin, boasting an attendance of 356,770 in 1958 and 683,995 in 1968, or an increase of 91 percent. Income also has increased by 140 percent for this period.

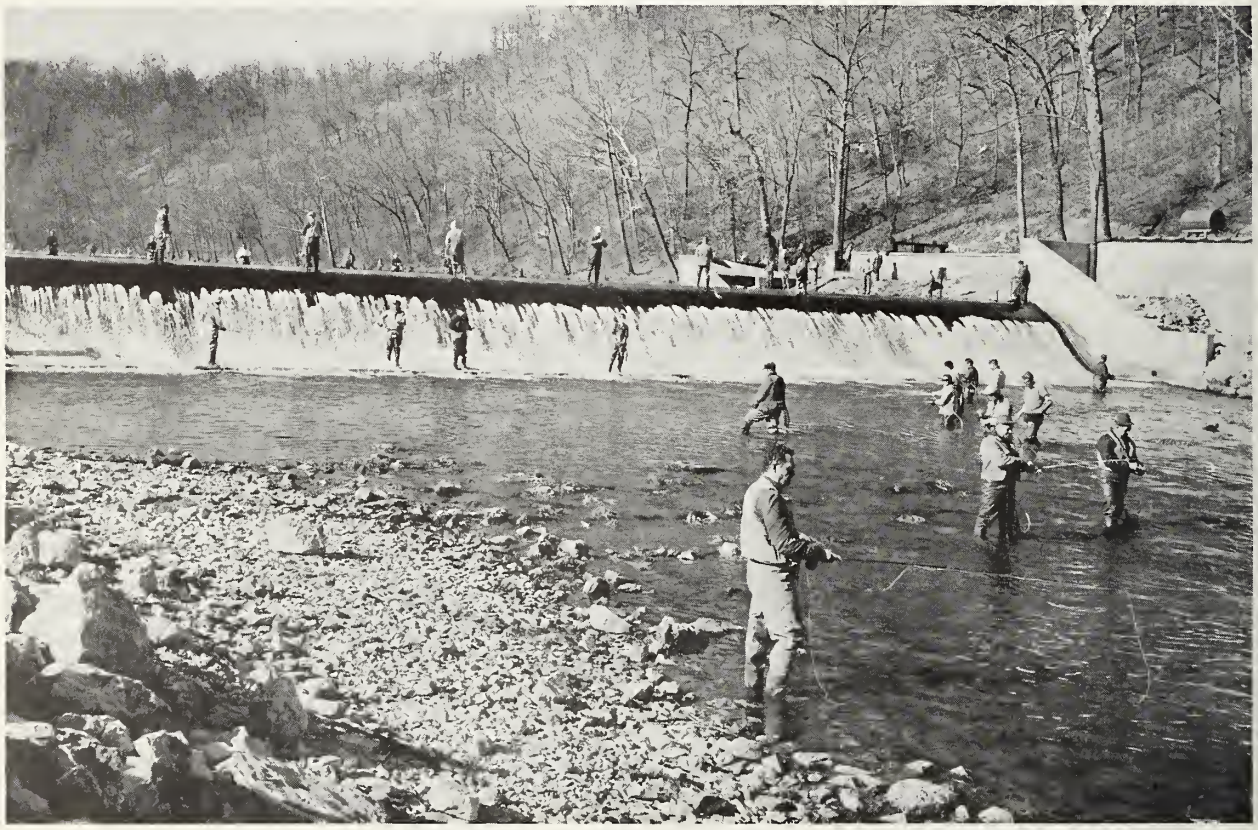


Photo by: Walker-Missouri Tourism

Bennett Springs State Park - Clear spring water provides the setting for this recreational area.

Pomme de Terre State Park, located three miles west of Hermitage, includes 364 acres of land adjacent to the 7,800-acre multi-purpose lake. Pomme de Terre Lake was completed in 1961 and visits to this park have increased yearly to a total of 265,537 in 1968. Park earnings since 1963 have increased 465 percent.

Stockton Reservoir is nearing completion; after the nine proposed public use areas are completed on the 24,900-acre lake, annual visitor days are estimated at 1.5 million. Kaysinger Bluff Dam is still under construction. The Corps of Engineers has identified 17 potential public use areas

that appear suited for initial development. Other sites have been investigated to meet future demand. It is anticipated the 55,600-acre lake will provide two million annual visitor days of recreation.

In addition to the public parks and recreational areas, private recreational developments are of significant economic importance. Private development has occurred around Pomme de Terre at a rapid pace since the completion of the reservoir in 1961. Most noticeable is the number of new summer homes and boat storage buildings.

The most well known, privately developed recreational area is the Lake of the Ozarks. The Lake is 129 miles long and covers about 65,000 surface acres with 1,375 miles of shoreline. Development of recreational facilities has proceeded at a rapid rate, since most of the land around the lake is available to private interests.

Photo by: Walker-Missouri Tourism

A private resort on the Lake of the Ozarks.

The economic impact created by the Lake of the Ozarks is shown by the 2,300,000 overnight guests in the immediate area during the 1965 season. The 403 resorts on the lake have a total of 23,000 beds. Other facilities include 23 heated fishing docks, 14 major marinas, 4 golf courses, and 5 caves.

The inventory of all outdoor recreation facilities in each county in Missouri was made in 1966 for the Missouri Inter-Agency Council for Outdoor Recreation. The supply of recreational facilities was measured in terms of recreational activity days (Table 29).

Table 29. Capabilities of Recreational Facilities by Counties, 1965 2/: South Grand-Osage River Basin, Missouri

County	Supply, annual activity days						
	Swim	Picnic	Camp	Boat	Hunt	Fishing	Other 1/
Barton	52,500	63,360	4,625	-	-	29,537	50,800
Bates	-	86,400	-	-	28	3,425	88,200
Benton	4,186,560	28,800	1,200	9,792	321	836,900	-
Camden	77,487,372	288,000	281,200	264,384	18	12,142,305	275,800
Cass	-	756,000	6,250	-	-	4,950	270,000
Cedar	33,174	40,320	6,000	-	31	375,337	197,400
Dade	15,000	11,520	-	-	-	1,305	33,600
Dallas	6,000	23,040	-	-	182	1,150	54,600
Greene	414,960	1,457,280	205,775	9,792	59,940	71,765	1,398,200
Henry	30,000	305,280	15,200	-	381	61,235	42,000
Hickory	1,829,520	817,920	443,000	68,544	-	119,005	9,400
Miller	7,869,600	40,320	12,200	19,584	7	2,075	1,000
Morgan	20,663,040	69,120	4,200	19,584	40	1,880	66,300
Polk	600	-	-	-	142	455	21,000
St. Clair	2,120,880	63,360	6,650	-	212	16,112	16,800
Vernon	30,000	40,320	11,825	-	790	31,705	75,600
TOTAL	114,739,206	4,091,040	998,125	391,680	62,092	13,699,141	2,600,700

1/ Includes playfield, horse trails, foot trails, and bike trails.

2/ Statistical Summary of the Missouri Recreation Survey, 1966, Vols. I-III, Midwest Research Institute, Kansas City, Missouri.

A survey conducted by the University of Missouri in 1960 of 797 retail businesses in five counties surrounding the Lake provides estimates of the contribution of recreation activities to the economy of the area (Table 30).

Table 30. Estimated Volume of Business Attributed to Tourist Activity, Lake of the Ozarks Area, 1959 1/: South Grand-Osage River Basin, Missouri

Type of Firm	Volume of Business		
	From All Sources	Attributed to Tourist Activity	
	(1,000 Dollars)	(Percent)	(1,000 dollars)
Groceries	10,300	13.6	1,400
General Merchandise	3,700	18.9	700
Apparel and Accessories	1,000	10.0	100
Drugs	700	14.3	100
Taverns, Liquor Stores and Bars	1,000	35.0	350
Restaurants	2,400	50.0	1,200
Furniture, Home Furnishings	1,400	14.3	200
Lumber, Building Materials, and Hardware	5,700	14.0	800
Automobile Dealers and Garages	8,600	16.3	1,400
Gasoline Service Stations	4,600	30.4	1,400
Farm Supplies and Agricultural Products	1,600	6.3	100
Amusements	1,100	33.6	370
Other Retail Stores	3,300	12.1	400
Motels and Hotels	5,500	94.5	5,200
Selected Service Firms	800	3.8	30
All Sources	51,700	26.6	13,750

1/ "Where Ozark Tourists Come From and Their Impact on Local Economy." Research Bulletin 798, University of Missouri, College of Agriculture, March, 1962, Page 6.

Recreation accounted for about 27 percent of the volume of business for the firms listed. Motels and hotel businesses were the highest beneficiaries, while selected service firms were lowest.

F. Relationship Between Economic and Water Resource Development

The contribution of water resource development to economic development within the Basin depends on the market demand for goods and services produced by water and related land. Prices are the market signals that call forth or reduce the amount of input resources used to produce goods and services. If the demand for a given good or service produced by water and land resources increases over time and the relative prices of inputs remain the same, we would expect an increase in the demand for water and related land resources. Prices would indicate the extent of development needed to economically meet demands, and water resource development could be planned accordingly.

The demand for water and related land resources would be less difficult to ascertain if the Basin were an economic entity -- that is, if the economy were on a self-sustaining basis with no exports or imports. The Basin is, however, a hydrologic area, not an economic entity; and much of the demand for goods and services produced by the Basin's water and related land is generated by forces outside the Basin. Thus, most producers of goods and services have little control over the prices for products and services provided.

Because of the dependency of the Basin on a larger marketing area for disposal of its output, projections must be made of the expected shares of goods and services to be provided by the Basin area. These projections are necessary because use of current normal prices is valid only for that quantity of goods and services that will clear the markets at these prices. If more is produced than will clear the markets, then either prices for goods and services will go down, surpluses will accrue, or developed resources may not be used to the extent anticipated. The National benefits of water resource development is that part of the projected goods and services for the Basin met by economical development of water and related land resources. The benefits may be in terms of savings in costs of production or in terms of benefits foregone if the development is not undertaken.

The regional economic benefits of water resource development are greater and more direct than the National. In a short period, the Basin can supply and sell more than its projected share of goods and services produced through water and land resource development. Also, in a longer period, a large proportion of these shares might be retained by the Basin at the expense of another area. Thus, although the economy of the Basin may benefit significantly through water resource development, the gain to the Basin may be offset by a corresponding loss in economic development in another area. Therefore, regional benefits must be viewed in terms of such goals as improving incomes, employment, and the stability of the Basin's economy.

IV. WATER AND RELATED LAND RESOURCE PROBLEMS

The analysis of Basin problems is an important and essential part of the study. The causes, extent, and frequency of the resource problems and some of the social and economic consequences are discussed below.

A. Erosion Damage

Heavy rains of three to eight inches, usually occurring in the spring and early summer when cover is in poor condition, cause severe erosion damage to sloping lands. Most damage is from sheet and rill erosion. Although streambank erosion is extensive, damage intensity is low. Wind erosion occurs when droughty conditions or inadequate cover leave topsoil exposed. Minor areas of gully erosion are confined mostly to Land Resource Area 112. Unstable roadside and drainage ditches contribute to the problem.

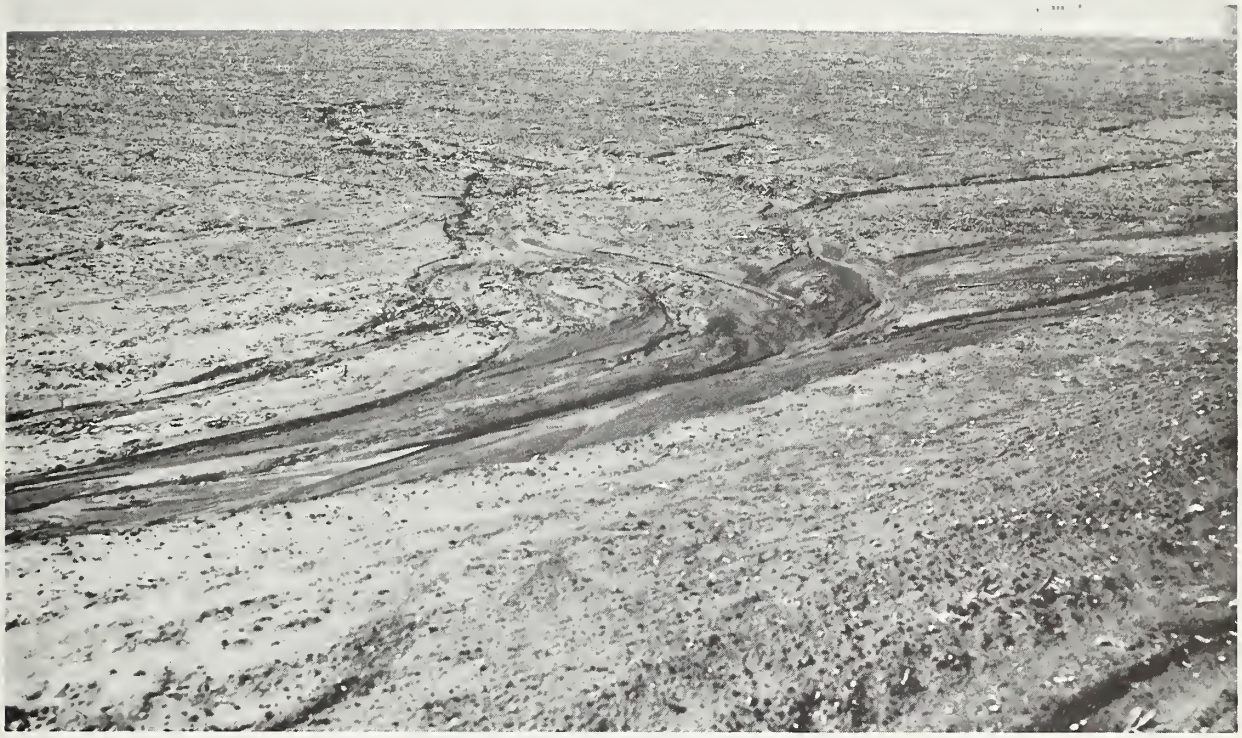
Intensive land use in small confined areas contributes to the problem of erosion and pollution. New housing developments leave land bare for months, and intensive confinement of turkeys, hogs, and cattle denudes the landscape leaving it subject to erosion.

The Conservation Needs Inventory indicates that approximately two-thirds of the soils in cropland, pasture, and forest are subject to erosion hazards. The percentage of soils with erosion hazards by land use within each land resource area is shown in Table 31.

Inherent sandy or stony characteristics make soils droughty or limit their usefulness. These soils occur on 8 percent of the land in LRA 112 and 14 percent in LRA 116.

Table 31. Soils Having Erosion Hazards: South Grand-Osage River Basin, Missouri

Land Resource Area	Land Use	Total Basin Area (Acres)	Soils With Erosion Hazards (Acres)	%
112	Cropland	1,196,800	809,400	68
	Pasture	578,900	420,400	73
	Forest	427,200	280,500	65
	Total	2,202,900	1,510,300	68
116	Cropland	1,087,500	713,600	66
	Pasture	916,200	625,800	68
	Forest	1,898,000	1,230,400	65
	Total	3,901,700	2,569,800	66
Total Basin		6,104,600	4,080,100	67



Sheet and rill erosion continues to be a problem.

Flood flows caused erosion damages to this road bed.

An estimate of streambank erosion in drainage areas of less than 400 square miles was made as a part of the National Assessment of Streambank Erosion Study (Table 32).

Table 32. Streambank Erosion on Drainage Areas Less Than 400 Square Miles: South Grand-Osage River Basin, Missouri

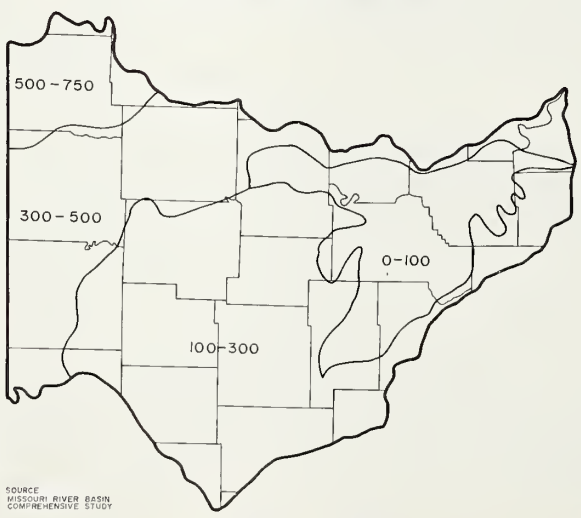
LRA	Description	Bank Erosion Conditions		
		Moderate	Severe	Total
112	Bank Miles	160	90	250
	Damage	$10,710	$14,630	$25,340
116	Bank Miles	300	230	530
	Damage	$30,280	$35,470	$65,750
Total	Bank Miles	460	320	780
	Damage	$40,990	$50,100	$91,090

Total damages from streambank erosion generally are from three sources: (1) land damage 50 percent, (2) sediment damage 10 percent, and (3) damages to other property 40 percent.

B. Sediment Damage

Sediment, a product of erosion, is transported by runoff water. Sheet and rill erosion of cropland and pasture produces most of this sediment. Although the farm is the primary source of sediment, it is also produced by surface mining, roadbanks, eroding streambanks, highway construction, and housing developments. Sediment yields are relatively low -- less than one ton per acre per year (Map 12).

MAP 12: SEDIMENT YIELDS TONS/SQ. MI./YEAR
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



A study from 1931 through 1939 revealed that the Lake of the Ozarks received 7,000 acre-feet of sediment annually. This sediment has resulted in the loss of storage capacity, damage to turbines and other equipment, and the loss of recreational opportunities. Sediment yields are not continuing at this rate because of changes in cultural practices throughout most of the Basin.

Until straightened and improved, most channels in Land Resource Area 112 were small and meandering. Channel straightening on the main stems of the South Grand River and Big Creek were made using "pilot channels." As the new channel eroded and enlarged, the sediment was deposited downstream seriously reducing channel capacities. The lower reaches of Big Creek and the South Grand River have experienced heavy sedimentation which is causing swamping and frequent flooding on 7,500 acres. If all erosion could be stopped, streams would take many years to scour out and remove present deposition.

Small reservoirs for municipal water supply and ponds for livestock water are losing capacity because of the accumulation of sediment. Reservoirs at Appleton City, Harrisonville, and Pleasant Hill have water supplies endangered by sediment reducing the available storage.

C. Floodwater Damage

Floodwater damage evaluations have been made considering three major flood prevention projects of the Corps of Engineers in place. These projects are Kaysinger Bluff, Pomme de Terre, and Stockton Reservoirs. Bagnell Dam, constructed by the Union Electric Company, gives incidental flood benefits during floods of short duration.

The flooding of an estimated 371,900 acres of bottomland causes extensive damage to crops and pasture. Approximately 112,300 acres of this total is along the main stem of the Osage, Marais des Cygnes, Little Osage, and Marmaton Rivers. The remaining 259,600 acres flooded are in the tributaries to the main stem rivers.

Other agricultural damage includes damage to fences, farm buildings, and cost of debris removal. Most of the non-agricultural damage is associated with road and bridge damage. Fallen trees and debris in the streams cause log jams at many bridge crossings. This causes flood flows to overtop roads and wash out bridge abutments, resulting in transportation losses because of detours.

The town of Pleasant Hill in the upper reaches of Big Creek sustains damage from the major floods. Recreational developments along the Lake of the Ozarks are damaged from the fluctuating lake level caused by excessive runoff. Recreation opportunities are lost because of the hazards of debris carried by flood water. The cost of log and debris removal around the Lake is an added expense.

Local floodwater damage to agricultural land was assessed on the basis of hydrologic-economic analysis utilizing field surveys of valley cross sections on the early-action watersheds. This crop and pasture damage was converted to yield differentials for flooded, flood protected, and flood-free

Corn and soybeans account for 80 percent of crop and pasture damage.

Levee failure and inundation of roads frequently cause losses along Big Creek.

conditions. The yield reductions for the various crops within each economic soil resource group were expanded to total bottomlands to determine total production losses. The net value of the lost production by crops is shown in Table 33.

Table 33. Current Normal Annual Loss in Crop and Pasture Production and Value of Loss: South Grand-Osage River Basin, Missouri

Crop	Acres flooded	Loss in production due to flooding		Net Value of lost production
	Acres	Unit	Production	1,000 dollars
Corn, grain	85,630	bu.	123,990	1,344
Soybeans	32,120	bu.	17,440	411
Sorghum grain	9,850	bu.	99,710	95
Wheat	19,230	bu.	78,830	88
Oats grain	6,070	bu.	21,670	11
Barley grain	1,910	bu.	7,080	5
Corn silage	4,470	100 F.U.1/	17,610	23
Sorghum silage	3,850	100 F.U.	17,200	24
Alfalfa hay	3,940	100 F.U.	18,520	24
Other hay	10,070	100 F.U.	18,230	19
Pasture	77,450	100 F.U.	75,770	146
Grazed forest land	67,000	100 F.U.	6,700	13
All other land	50,310	--	--	--
Total	371,900		--	2,203

1/ Feed Units.

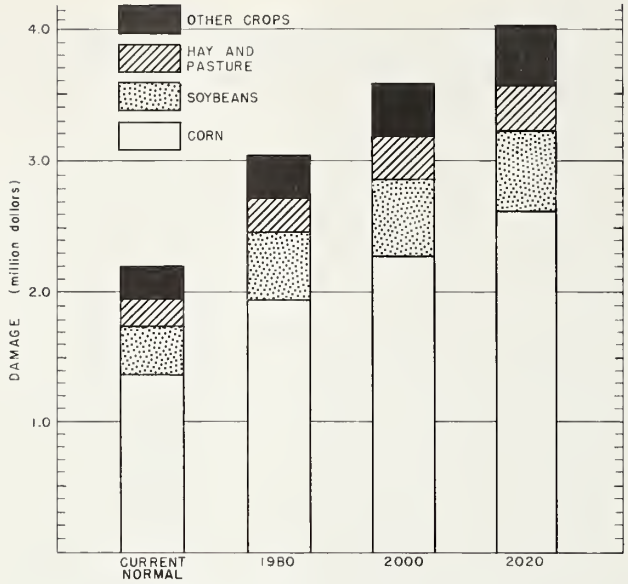
Although corn is grown on only 23 percent of the flooded area, it accounts for 61 percent of the flood damage. Together, corn and soybeans are grown on only 32 percent of the flooded area but account for 80 percent of the total crop and pasture damage. Conversely, pasture and grazed forest land constitute 38 percent of the flooded acres and account for only 8 percent of the damage.

Future crop and pasture damage was determined by assuming that without resource development for flood protection, land use in the flood plain would remain about the same as present because of the flood hazard. Damage, however, will increase because of higher yields on both flooded and flood-free soils. Thus, absolute yield differences between crops on flooded and flood-free soils will increase, and damage will increase correspondingly.

Projected damage to crops and pasture in the flood plain is illustrated in Figure 12. Total annual crop and pasture damage is expected to increase to about 3.0 million dollars by 1980, to 3.6 million by the year 2000, and to 4.0 million by the year 2020 if flood control reservoirs are not constructed.

Total potential floodwater damage under future conditions was obtained through the use of economic indices from the Type I studies. The projection

FIGURE 12: PRESENT AND PROJECTED AVERAGE ANNUAL FLOOD DAMAGE TO CROP AND PASTURE LAND SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



CURRENT NORMAL REPRESENTS A FIVE YEAR AVERAGE, 1959—1963

considers such basic elements as population and employment growth, growth in income and earnings, and agricultural production trends. Current annual damages of $2,640,000 include damage to crops and pasture, other agricultural, non-agricultural and indirect damage. Current annual damages projected to year 2020 would increase to an estimated $7,319,000 (Table 34).

Table 34. Current and Projected Annual Floodwater Damages: South Grand-Osage River Basin, Missouri

Watershed Area	Acres Subject to Flooding	Average Annual Floodwater Damages Current Normal	Projected Economic Development 1980	2000	2020
	(000)		(thousands of dollars)		
LRA 112					
Main Stem	82.0	630	851	1,233	1,846
Tributaries	143.1	1,394	1,847	2,603	3,698
Total	225.1	2,024	2,698	3,836	5,544
LRA 116					
Main Stem	30.3	86	124	208	369
Tributaries	116.5	530	703	990	1,406
Total	146.8	616	827	1,198	1,775
Summary					
Total Main Stem	112.3	716	975	1,441	2,215
Total Tribs	259.6	1,924	2,550	3,593	5,104
Grand Total	371.9	2,640	3,525	5,034	7,319

D. Impaired Drainage

Agricultural drainage problems may be caused by excessive surface or subsurface water or both. Soils with these problems require drainage for maximum crop and pasture use. In addition, many of the bottomland soils that flood also have drainage needs. Soils with inherent wetness hazards, according to the Conservation Needs Inventory, occur on 689,420 acres (Table 35). Of this total, 335,000 acres are flat upland soils with internal drainage problems caused by claypan layers.

Table 35. Soils with Wetness Problems: South Grand-Osage River Basin, Missouri

Land Resource Area	Cropland	Pasture	Forest	Other	Total
			(Acres)		
112	287,720	61,200	75,900	19,940	444,760
116	169,470	38,410	31,460	5,320	244,660
Total	457,190	99,610	107,360	25,260	689,420

E. Forest Management and Development

Problems encountered in the forests affect the water and related land resources and the forest economy. Water supply, flooding, erosion, and sedimentation are directly influenced by prior land use.

A forest stand may be fully stocked with timber and therein provide adequate watershed protection; but if the stocking consists of low-grade or cull trees, it will not provide an economic return to the landowner. Watershed protection can just as well be provided by well managed forest stands, and owner interest can be stimulated by the receipt of returns from sales of timber to wood-using industries.

Problems affecting the water and related land resources are divided into the following four categories:

1. Fire Damage

Fire is the greatest single factor responsible for poor forest conditions. It was once a widespread custom in the Ozarks to burn the woods frequently. Nearly every stand in the Basin shows signs of past fire disturbance.

Organized fire protection is available today on 32 percent of the Basin; almost one-fifth of the unprotected area burns annually. Most of the man-made fire problems have been isolated to particular hot spots such as the Lake of the Ozarks area.

Between 1962 and 1966, almost one million acres burned; many of these same areas are burned annually. A 100-acre forest area, burned in four consecutive years, would be reported as 400 acres total burn. Wild fire destroys the litter and humus layers on the forest floor, kills young tree and shrub

reproduction, and damages or kills the larger pole and sawtimber trees. The mortality due to fire is equivalent to about five percent of the sawtimber volume cut annually. Even greater, but not so easily measured, are the indirect effects of growth retardation, reduction in quality, and the reduction in resistance to disease and insect infestation.

Photo by: Woolridge - Missouri Department of Conservation

Grazing and wildfire destroy litter and humus in forest stands.

2. Grazing

Both grazing and fire lower the forest stands' hydrologic condition. Forest hydrologic conditions as determined from litter and humus measurements on representative samples of forest sites will range from a little over one percent of the forested portion in very good condition to 72 percent in very poor condition (Table 36).

Table 36. Forest Hydrologic Conditions: South Grand-Osage River Basin, Missouri

Forest Hydrologic Condition	Forest Area	
	(Thousand Acres)	(Percent)
Very good	34.6	1
Good	69.1	3
Fair	299.8	13
Poor	265.0	11
Very poor	1,656.7	72
Total Area	2,325.2	100

Destructive grazing on forest land lowers the ability of the forest soil to absorb and transmit water. The litter and humus layer of the forest floor is destroyed, soil is compacted, or in the case of hogs, disturbed and reproduction is demolished. Approximately 1,500,000 acres of forest land is grazed.

3. Indiscriminate Land Clearing

Ozark cattlemen have become increasingly interested in converting forest land to pasture and range, either by using aerial application of herbicides or bulldozers. Much of this clearing occurs on soils or topography that is unsatisfactory for maintaining adequate grass cover. While forest sites with low productivity can be converted to pasture for an apparently nominal investment, maintenance costs in areas where topography or soils are not suited to sustained grass production could prove prohibitive.

The most promising conversion areas are usually limited to the ridgetops, especially in the eastern portion of the Basin. Aerial spraying, however, is nonselective and wind drift may move the spray into more valuable timber areas. At the present, the effects of this practice on stream pollution are questionable.

4. Improper Logging Practices

Logging, when carried out with little regard for the residual stand, is detrimental. It can reduce the stocking and quality of future forest stands and create runoff and erosion problems.

Studies indicate a direct relationship between the severity of harvest methods and the increase in water discharge on forest land.

Roads and skid trails in the harvest area, when not well planned, can produce gully erosion. Roads with unprotected cuts, fills, and ditches can add measurably to the amount of sediment reaching drainages and riverbeds.

Problems affecting the forest economy include the following two categories:

1. Disease and Insects

Currently disease and insects are responsible for more than one-fourth of the timber mortality in the Basin. The effects of disease and insects on timber growth and quality are estimated to be even greater. Disease or insect infestation usually affects only one or two host species in the forest. No accurate measure of these effects has been made, and figures are not available on the effects of production.

2. Stocking

Repeated burning, heavy grazing, insects, disease, and weather conditions have contributed to the reduction of volume and quality of most forest stands. Harvesting the best and leaving the worst also has contributed to the degradation of the forests. All but a few stands are greatly understocked. The average volume (230 cubic feet) per acre of commercial forest land falls far short of the potential.

Almost one million acres of commercial forest land is either nonstocked or unsatisfactorily stocked with seedlings. Most of the remaining 1.3 million acres of commercial forest land is understocked. Stocking averages approximately 480 cubic feet per acre. The potential ranges from 363 cubic feet per acre on the poorest sites to 5,032 cubic feet per acre on the best sites. The volume varies by age class (Table 37).

Table 37. Normal Yield Per Acre Total for Stand Life[1/]: South Grand-Osage River Basin, Missouri

Age	Upland Oak Stands To a 4" Top		
Years	Poor Site	Medium Site	Good Site
		Cubic Feet 2/	
30	363.4	821.6	1,374.6
50	1,232.4	2,069.8	2,915.1
60	1,627.4	2,599.1	3,547.1
70	1,982.9	3,057.3	4,092.2
75	--	3,262.7	--
80	2,298.9	3,468.1	4,574.1
90	2,583.3	3,831.5	5,032.3

1/ Missouri Conservation Commission, 1962. Excerpts from TM plans, Clark National Forest, Missouri, U. S. Forest Service.

2/ 79 cubic feet = 1 cord.

A large percentage of the current stocking is in poor storage, harvest or cull trees (Table 38).

Table 38. Proportion of Trees by LRA, Species Group, and Tree Quality Class, 1969: South Grand-Osage River Basin, Missouri

Species Group	Good Crop 1/ or Storage 2/	Poor Crop or Storage 3/	Cull Sound 4/	Cull Rotten 5/	Total
		(Percent)			
LRA 112					
Softwoods	13.8	10.2	49.4	26.6	100.0
Premium Hardwoods	5.4	64.1	21.9	8.6	100.0
Other Hardwoods	.8	63.2	26.7	9.3	100.0
All Species	4.4	63.9	23.0	8.7	100.0
LRA 116					
Softwoods	4.0	43.0	52.0	1.0	100.0
Premium Hardwoods	4.0	58.0	25.0	13.0	100.0
Other Hardwoods	4.0	58.0	25.0	13.0	100.0
All Species	4.0	57.0	26.0	13.0	100.0

Footnotes: Table 38

1/ Good crop tree - a sound, vigorous, dominant or co-dominant growing stock tree that has good form and a good crown. The tree must be the most desirable species for the site and must have a butt log of grade 2 or better.

2/ Good storage tree - a good growing stock tree that does not meet all the specifications of a crop tree but in form and soundness is a suitable leave tree.

3/ Poor storage tree - a poor growing stock tree that would normally be removed in harvest or intermediate cuttings but may be left if desired.

4/ Sound cull - a non-growing stock tree. Fifty percent or more of the tree is defective and less than half the defect is due to rot.

5/ Rotten cull - a non-growing stock tree. Fifty percent or more of the tree is defective and more than half the defect is due to rot.

The large percentage of trees in the poor or cull group (96 percent in both resource areas) represents a waste in growing space. The high incidence of rot or other defects causing the trees to be so classified contributes to a net reduction of present volume plus decreases in the growth rate. Large numbers of trees find their way into the sound cull category because they are considered as non-commercial species.

These conditions, while not induced by the lack of markets for low-grade material, are perpetuated by it. By developing industry which can utilize low-grade or small material, an incentive for management could be stimulated. The net result would be a continual up-grading of the existing pole and saw-timber stands and the planting of non-stocked or poorly stocked stands, thereby making the forests more productive.

F. Water Shortages

Variation occurs in year-to-year rainfall with lows of 18 to 20 inches and highs 60 to 65 inches. Long, hot dry spells during the summer months are not infrequent and cause reduced crop yields. In 40 years, 100 dry periods lasting two weeks have occurred in the growing season from May through August. Of these, 56 were in July and August. Dry periods that lasted three weeks occurred 41 times.

The effect of these dry periods is reflected in the yields of corn. In 1966, a dry year for Barton County, corn averaged 31.3 bushels per acre, while in 1968 the average was 78.0 bushels per acre. Studies show that irrigation can increase average corn yields 35 bushels. A study at Columbia, Missouri, concluded that up to 75 percent of corn yield variation was related to drought.

Drought creates an impact on growth and mortality in forests. In the Northwestern Ozarks, which includes Land Resource Area 116, only 10 percent of the total sawtimber growth accrued on existing sawtimber trees. The

remaining 90 percent of the sawtimber volume increase was due to ingrowth, i.e. the total volume of poletimber trees that reached sawtimber size (11.0" diameter) and shifted into the sawtimber category.

In fact, the high mortality caused a net reduction in volume for some species. Growth on red oak species was only 1.4 percent annually. In the Missouri Prairie Region which includes LRA 112, the total annual growth of black oak was negative.

Livestock water supplies are obtained from wells, farm ponds, streams, and springs. These supplies are generally adequate except during prolonged drought. As farm ponds are depleted or wells fail, it has been necessary for some farmers to obtain water from nearby municipal supplies. Most community systems provide tank-filling facilities and sell water to farmers for livestock and domestic use. In the western part of the Basin, the low quality of ground water results in curtailed domestic use even under normal conditions. Dissolved solids content ranges from 1,000 to 3,000 parts per million.

Hauling water for domestic use in an area of low quality ground water.

Communities have experienced water shortages during drought periods. This has been due primarily to lack of adequate storage facilities rather than to a deficiency of the water resources. Under Missouri law, the responsibility for providing water service is permissive to local government. Limitations on indebtedness by municipal government necessitates selection of priority between investments in facilities to provide services. In most

instances, expansion of water supply facilities is not considered until a few years before critical shortages are anticipated. Occasionally, drought or unexpected population increase necessitates emergency action. The identification of potential municipal water supply storage in multi-purpose structures will serve to inform water supply officials of both short-term and long-term opportunities.

Opportunities for water-based recreational activities will be enhanced with the addition of Stockton and Kaysinger Bluff Reservoirs to the existing Pomme de Terre and Lake of the Ozarks Reservoirs. The four large reservoirs will provide extensive opportunities for people with the time and resources to travel to the recreational sites. However, facilities for day recreational use are limited for large population centers in and adjacent to the Basin. All the large reservoirs mentioned above are more than 75 miles from Kansas City and Springfield. Reservoirs are needed within day use travel distance of these centers, and the demand for facilities in this area is the major consideration in the analysis of recreation.

G. Surface Water Quality

Three major factors affecting surface water quality are agriculture, mining, and waste disposal.

1. Agricultural Pollution

Sediment is the major pollutant of flowing streams and reservoirs in the Basin. The major source of sediment is from agricultural land, particularly that which is used for row crops and grain. Other sources include surface mining, urban and highway construction, eroding stream banks, and unstabilized road ditches.

The presence of sediment, defined generally as any sized material moved or transported by the stream, has a deteriorating effect on many of the functions served by the water resource. The turbidity discourages recreational use since the full enjoyment of the stream includes visual observation of the stream bottom. Swimming and other water contact activities are not enjoyed in turbid water, and greater danger exists by reason of poor visibility beneath the surface.

Sediment or turbidity can increase water treatment costs, not so much from its presence as from the fluctuation in quantity which requires changed treatment processes and associated operation costs. Habitat for site-feeding fish such as bass and sunfish is adversely affected by excessive silt and turbidity; however, fishes which have adapted to the turbid waters such as catfish, drum, sturgeon, etc. thrive in these areas.

Sediment also causes natural damming of streams, usually started by lodged debris, and contributes to the formation of natural levees which interfere with drainage of adjacent lands.

Other pollution originating on agricultural lands enters the stream through runoff water from the land. It may be organic or chemical in nature and may be natural or result from man's use of the land. Decayed organic

material, such as leaves or grasses, can exert an oxygen demand on the stream, but more often it imparts a color to the water by dissolved organic dyes. Agricultural practices contributing pollution of this nature include over-application of pesticides, herbicides, and fertilizers. Materials used for these purposes can enter the stream attached to clay and silt particles or in solution. They can cause fish kills, destroy aquatic plants and generally disrupt the ecological balance of the stream. Nitrate and phosphate compounds used as fertilizer can cause excessive plant growth if permitted to enter the stream. Excess algal bloom resulting from over-fertilization of the stream can kill fish by clogging the gills or can deplete oxygen during the cycle of photosynthesis with suffocation of fish resulting. The extent of use of pesticides, herbicides, and fertilizers is shown by subbasin in Table 39. Subbasin delineation is on Map 13.

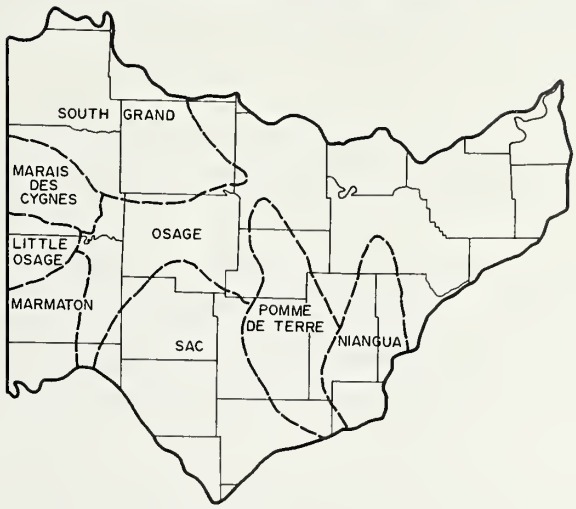
Table 39. Land Use, Fertilizers, Insecticides, and Herbicides: South Grand-Osage River Basin, Missouri

		SUB-BASINS							
	Unit	Osage	Sac	Marmaton	South Grand	Niangua	Little Osage	Marais des Cygnes	Pomme de Terre
Sub-basin area	Sq. Mi.	3,567.0	1,970.3	543.4	2,022.1	1,010.3	244.1	454.1	841.8
Land area in sub-basin									
Field Crops (excl. hay)	Percent	10.3	12.8	34.4	26.9	3.3	33.0	35.6	7.3
Class IIIe & IVe	Percent	15.6	23.1	26.7	23.0	16.2	24.7	24.7	21.4
Fertilizer applied on Crop & Pasture									
Nitrogen	Tons	5,062.0	4,306.0	1,952.0	9,381.0	741.0	882.0	2,418.0	1,068.0
	T/Sq.Mi.	3.6	3.9	5.5	7.8	2.1	5.6	6.8	2.9
P_2O_5	Tons	6,218.0	6,245.0	2,248.0	9,457.0	1,210.0	984.0	2,474.0	1,711.0
	T/Sq.Mi.	4.4	5.6	6.4	7.9	3.5	6.2	7.0	4.6
Selected Insecticides applied on Corn									
Soil	Acres	28,408.0	12,538.0	4,429.0	39,964.0	352.0	3,536.0	19,980.0	1,721.0
	Ac/Sq.Mi.	8.0	6.4	8.2	20.3	---	14.5	44.0	2.0
Corn borer	Acres				1,030.0				
Soybean Herbicides									
Sprayed	Acres	6,503.0	2,000.0	6,018.0	15,081.0	1.0	2,686.0	5,400.0	189.0
	Ac/Sq.Mi.	1.8	1.0	11.1	7.5	---	11.0	11.9	0.2

From Agricultural Inventory by Drainage Basins, May 1968, by University of Missouri at Columbia.

Another source of pollutants is from animal wastes resulting from local concentration of livestock in barnyards and feedlots. No large commercial feedlot operations are known at the present time. Average concentration of livestock in the Basin is: cattle - 78 per square mile; swine - 31 per square mile; and poultry - 242 per square mile. Additional research and investigation is needed to determine the extent of the agricultural pollution problem.

MAP 13: SUBBASINS
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



2. Mine Wastes

About 25,500 acres of land has been disturbed by open pit or area strip mining for coal, limestone, sand and gravel, sandstone, barium, and iron. Of this, strip mining for coal has piled high banks of spoil on 25,000 acres. Pollution from old and abandoned, as well as active, mines is a problem that cannot be solved under existing laws. Newer mining operations exercise control through seeding and tree planting. Although strip mining in Kansas is not contributing to interstate water quality problems, the expanding mining operations in the Miami Creek Watershed in Kansas and Missouri may cause water quality deterioration if not properly reclaimed.

3. Waste Disposal

All cities provide secondary treatment of sewage except Osceola. The large resorts on the Lake of the Ozarks also provide secondary treatment, although operation and maintenance is not always adequate. Clusters of smaller resorts and cottages, often in community setting, use septic tanks and tile fields for individual waste disposal. It is not known how many are properly constructed, but pollution from these latter sources may exceed the contribution from many of the incorporated communities.

Most industries discharge their wastes to municipal systems. The Kansas City Power and Light Company Plant at Montrose collects and buries its fly ash.

Urbanization and industrial development radiating from Kansas City and Springfield have the potential to deteriorate the quality of surface waters if control measures are not applied. Timely expansion of existing treatment facilities and construction of new treatment plants will be necessary to control this problem. The water pollution laws of the State are considered generally adequate to cope with new pollution sources and to accomplish enhanced water quality by requiring modernization and expansion of

existing treatment facilities when needed. The Water Pollution Board exercises continued surveillance of water quality and requires new or expanded waste treatment facilities as indicated.

H. Fish and Wildlife

Little data is available on specific wildlife habitat. However, a study of prairie chicken habitat loss in the Basin and adjoining counties determined it had been reduced from 70,000 acres in 1945 to 45,000 acres in 1968.

Construction of reservoirs, such as Lake of the Ozarks, Pomme de Terre, Stockton, and Kaysinger Bluff, has changed or will change the fishery and wildlife habitat. Although reservoirs have reduced stream fishery, total fishery has been increased. Spawning areas for paddle fish, white bass, and walleye will be inundated by reservoir construction, making it questionable if the high quality stream fishery provided by these species can continue.

Many miles of streams have been inundated with subsequent loss of bottomland habitat for game species. Stream channel stabilization and rectification has caused losses in stream fishery habitat and reduced wood cover for game animals. Measures of this type enable more intensive land use practices which can further reduce game habitat.

I. Environmental Quality

The environment of the Basin has been changed over the years, and change probably will continue as man utilizes the resources of the region. However, change for man's benefit does not always need to be at the expense of environmental quality. The major portion of the Basin consists of land in agricultural use or forests. Utilization of the resource base has not always considered the long-range effect on the quality of the environment. Tilling of marginal lands, improper forestry practices, clearing, draining, and channel alignment have altered not only the hydrology, but have left scars that are unsightly. Technology has been developed to permit reclamation or correction of many of these practices, often with government assistance.

Uncontrolled urban expansion, particularly in those localities just outside the Kansas City and Springfield metropolitan areas, is the most important factor that can contribute to future environmental deterioration. Building of homes, industrial buildings, transportation routes, mining and activity associated with population growth have the capability to contribute to soil erosion and sediment, water and air pollution, and the loss of open space associated with rural living.

The people have available to them the legal mechanisms for preserving, improving, and maintaining the environment. These include authority to: adopt and apply zoning and building codes; operate sewage and refuse disposal systems; acquire and develop recreation facilities; establish special benefit districts for drainage, flood prevention, conservation of scenic and other valuable areas, and development of industrial parks.

The largest single influence on environmental quality is public attitude regarding the application of programs and controls designed to reclaim and

improve environmental conditions. A resistance to local governmental application of preventive measures has developed. Public support must be generated if environmental quality is to receive major consideration in growth and development.

V. PRESENT AND FUTURE NEEDS FOR WATER AND RELATED LAND RESOURCE DEVELOPMENT

Protection and management measures are needed on all watersheds in the study area. Much of the land is not used within its capabilities and treated according to its needs. The application of conservation treatments and practices to crop, pasture, and forest land is a basic step in the development and utilization of land and water resources. In addition, structural measures including channel improvement and reservoirs will be required to protect bottomlands and provide storage for water supplies and other beneficial uses.

Application of these practices has been impeded by slow acceptance of Soil Conservation Districts and their development of programs to combat soil and water problems. The remaining eight counties without Soil and Water Conservation Districts should be organized and programs developed to meet their needs for watershed protection and management.

A. Watershed Protection and Management

The Conservation Needs Inventory of 1968 shows that out of a total of 3.8 million acres of cropland and pasture, 68 percent or 2.6 million acres has an erosion problem. (Table 40) An additional 14 percent has inherent

Table 40. Conservation Treatment Needs: South Grand-Osage River Basin, Missouri

Land Resource Area	Land Use	Problem Area (Acres)	Adequately Treated (Acres)	%	Needs Treatment (Acres)	
Erosion Control						
112	Cropland	809,400	194,700	24	614,700	
	Pasture	420,400	98,700	23	320,100	1/
	Forest	10,780	7,000	65	3,780	
	Total	1,240,580	300,400	24	938,580	
116	Cropland	713,600	327,200	46	386,400	
	Pasture	625,800	97,000	16	528,800	
	Forest	106,400	16,500	16	89,900	
	Total	1,445,800	440,700	30	1,005,100	
TOTAL		2,686,380	741,100	28	1,943,680	
Soil Management						
112	Cropland	62,000	15,900	26	46,100	
	Pasture	72,200	7,100	10	64,700	1/
	Forest	413,520	52,300	13	361,220	
	Total	547,720	75,300	14	472,020	
116	Cropland	149,100	66,900	45	82,200	
	Pasture	237,600	26,500	11	209,700	1/
	Forest	1,708,200	485,400	28	1,222,800	
	Total	2,094,900	578,800	28	1,514,700	
TOTAL		2,642,620	654,100	25	1,986,720	

1/ Excludes 3,400 acres not feasible to treat.

soil conditions (such as: shallow, rocky, or droughty) that limit its capability and require special management. Only 28 percent of the erosion problem has been adequately treated. Over 1.8 million acres of crop and pasture lands remain to be treated with erosion control measures. Treatment needs have been applied to only 22 percent of the crop and pasture lands having soil management problems, leaving over 400,000 acres still needing treatment.

One million acres of cropland need mechanical practices such as terraces, diversions, contour farming, and stripcropping. Nearly 350,000 acres of cropland need permanent or annual cover and meadow in rotation.

Nearly 1 1/4 million acres of pasture need conservation treatment. About one-third need protection from overgrazing and improvement of present cover. One-third need to be reestablished in grass because of overgrazing. Brush control with some reestablishment needs to be applied to the other one-third.

Basin forest land is expected to decrease almost 210,000 acres by 2020. This loss necessitates the formulation of a forest development plan which must be followed if the future demand for wood products is to be met and this portion of the economy improved. The present and short-term needs are shown in Table 40.

Almost 1.7 million acres of commercial forest land need treatment. Rather than limit the assessment to primary needs, the total needs were evaluated, thus accounting for an acreage overlap where two or more treatments were needed on the same acre.

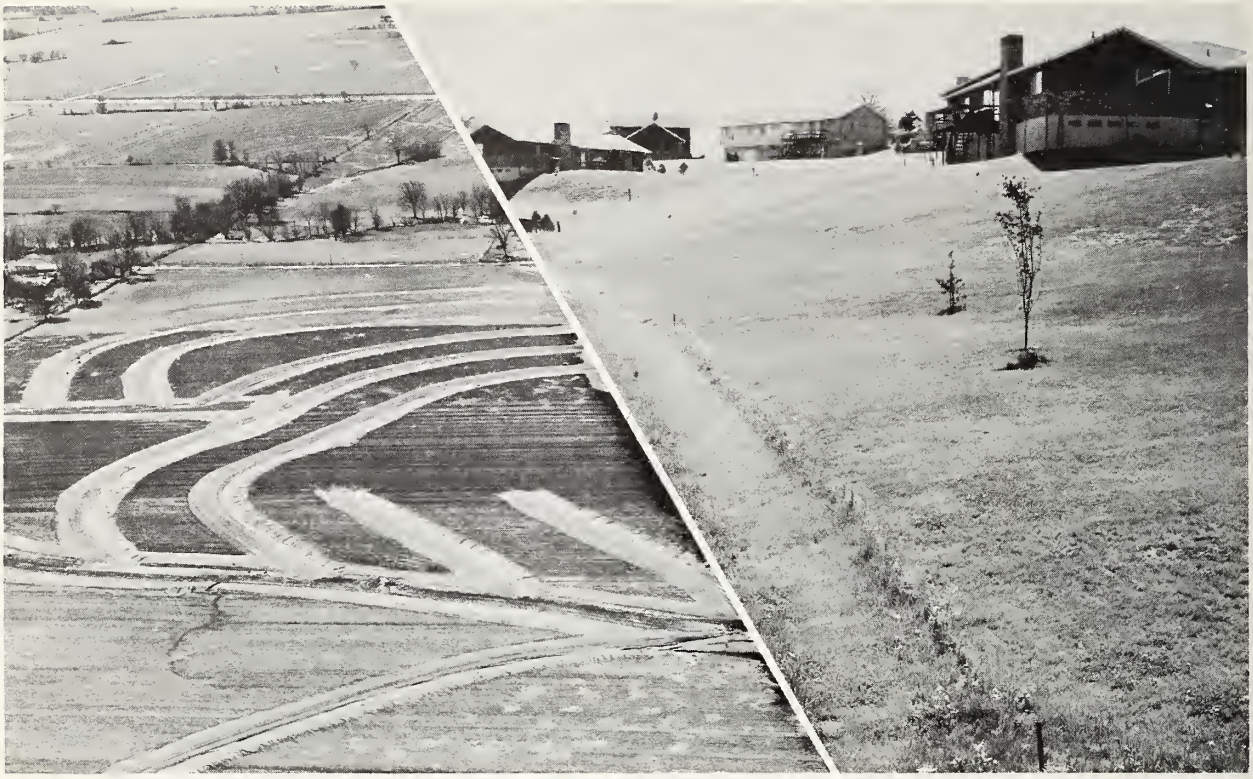
The 93,680 acres of forest land having severe erosion problems include 11,980 acres of log roads and skid trails which need stabilization.

A tree planting program aimed at the conversion of agricultural land being farmed beyond its capabilities and at the reenforcement of existing forest stands is needed on approximately 588,000 acres.

Grazing control is needed on over 1.5 million acres of forest land, and stand improvement is needed on 1.3 million acres.

Forest fires are a serious threat to planned programs for forest land management and treatment. Fire prevention and control intensification measures under the Cooperative Forest Fire Control Program are needed on the unprotected 68 percent of the forest land. Information and education programs dealing with fire pre-suppression should be expanded. More fire guards are needed to provide for early warning and fire suppression and to increase the effectiveness of the burning permit system.

Insect and disease damages which occur on forest land could be reduced through an intensified detection and control program. This program should include maintenance of current information on insect populations and disease conditions.



Terracing and diversion channels are needed to control water and erosion.

Photo by: Woolridge - Missouri Department of Conservation

Conservation treatment and management -- needed on pasture, hay and forest lands.

B. Sediment Control

Control of sediment is needed at its source: the farm, streambanks, channel scour, urban construction, surface mining, roadbanks and road ditches. The same practices that control erosion will prevent sediment deposition. Most sediment from the Upper Osage and South Grand Rivers will be deposited in Kaysinger Bluff Reservoir, which is under construction. Also, sediment control is needed throughout the Basin to prevent the loss of reservoir and pond storage capacity, damage to turbines, the loss of recreational opportunities, and deposition in channels. A need still exists to control sediment from direct tributaries to the Lake of the Ozarks in local areas where recreation facilities are affected.

C. Flood Prevention

Better utilization of the land resources is needed to stabilize agricultural income and production. Bottomland amounting to 371,900 acres is subject to flooding. Along the main stem of the Osage below Bagnell Dam, about 27,900 acres of bottomland is still subject to flooding from the uncontrolled tributaries and outflow of the reservoir. About 2,400 acres surrounding the Lake of the Ozarks that is highly developed for resort and recreational pursuits is subject to flooding and sediment damages. Above the five-year frequency flood pool of Kaysinger Bluff Reservoir, about 82,000 acres of flood plain on the main stem of the Osage, Marais des Cygnes, Marmaton, and Little Osage Rivers need protection from frequent storm events.

The tributaries to the mainstem rivers have an estimated 259,600 acres of flood plain. Land treatment measures and temporary storage in reservoirs and/or channel improvement are needed to reduce the damages on these flood plains.

As more land shifts out of agriculture into urban, roads, reservoirs, strip mining, and other uses, the pressure increases to intensify cultivation of the remaining bottomland for crop production. More profitable use of the flood plain could be made through controlling floods, using better crop rotation, applying adequate fertilizer, employing irrigation, and changing land use. Some woodland and brush on Class I and II bottomland soils could be converted to productive cropland. For example, of the 209,100 acres of Class I land in the flood plain, 100,300 acres are in grass and woodland. Conversely, low-lying land not economically protected for cropland could be managed for pasture, forest, recreation, or wildlife production. The town of Pleasant Hill is the only urban area left unprotected against floodwater damage from large storms. Both floodwater detention and channel improvement are needed to reduce flood damages in the town.

D. Drainage Improvement

Drainage is needed for stabilizing production and increasing efficiencies on individual farms. About 20 percent or 91,070 acres of the 457,190 acres of cropland soils having a wetness problem need drainage measures (Table 41).

Areas of claypan soils, 184,660 acres, have internal soil characteristics that require drainage and also erosion control. The need for these soils is

Table 41. Drainage Needs on Cropland: South Grand-Osage River Basin, Missouri

Land Resource Area	Drainage Needed	Adequately Treated	Other Wetness Problem	Total Wetness Problem
		(Acres)		
112	68,590	114,300	104,830	287,720
116	22,480	67,160	79,830	169,470
Total	91,070	181,460	184,660	457,190

to install a practice that will provide multi-protection for erosion and wetness. Practices such as cross-slope ditches and terraces provide this protection.

Photo by: University of Missouri

Intensive drainage practices are needed on cropland having a wetness problem.

Additional areas in pasture have wetness problems which would need correction if changed to cropland. Changing land use from cropland to pasture, forests, wildlife areas, recreational uses, or even open space should be considered as an alternate for drainage and a potential for meeting the needs of these uses.

E. Irrigation

From a local viewpoint, irrigation is needed to stabilize production and increase income above the existing low level. The economic activity of the area would be increased by expanding both the input and output sectors of the economy associated with irrigation. The input sectors include factors such as: irrigation water storage and distribution facilities, additional fertilizer, labor, and other factors of production. On the output side, additional income would accrue to farmers, buyers and processors of agricultural products.

Projected requirements of agricultural products for the Basin can be met without irrigation. Therefore, from a national viewpoint it might be concluded that development of water supplies for irrigation is not needed. However, some national benefits will occur because of stabilization of production and income, increased efficiency in production, and additional employment. Most of the benefits from irrigation would accrue to the regional and local area. Thus, the need for irrigation is primarily a local or regional need rather than a national need.

F. Rural Domestic Water and Livestock Water Supply

Rural domestic water is defined as that water used for drinking, culinary, and other household purposes in communities having populations of 5,500 or less. The source of supply may be from community water systems or from wells serving individual households. The amount of water used is related to the type of water facility available.

Many of the wells serving the individual households are improperly constructed and do not furnish a bacteriologically safe water supply. Contamination by nitrate concentration from surface runoff is common in improperly constructed wells. Also, according to University of Missouri findings, high nitrate concentration may cause loss of weight in beef cattle and reduced production in milk cows.

Organization of rural water districts is needed to improve the quality and safety of the water supplies serving the rural areas. An improved water supply and distribution system also can serve as sources for livestock water supply when improved quality is needed. Such districts are economically feasible in most areas that can provide at least four customers per mile of distribution line. In the western part of the Basin, it will usually be necessary to develop surface water sources to serve these systems since ground water sources are not reliable or are highly mineralized.

The daily use of water for domestic purposes was estimated on the basis of household use rates shown in Table 7, page 25. About 9,959,000 gallons was used daily for domestic purposes in 1960. Future uses were estimated on the assumption that 90 percent of the households will have running hot and cold water by 1980, and essentially all households will have this service by the year 2000. The rate of use is assumed to remain at about 150 gallons per household per day or about 50 gallons per person per day. Domestic use of water is expected to increase from the 1960 level by 42 percent in 1980 and more than double by the year 2000. (Table 42)

Table 42. Present and Projected Use of Water for Domestic Purposes: South Grand-Osage River Basin, Missouri

Year	Number of households	Use per household per day	Total Daily Use
	Number	Gallons	1,000 Gallons
1960	84,400	118	9,959
1980	104,000	136	14,144
2000	138,300	150	20,745
2020	177,700	150	26,655

Additional rural Water Supply Districts are needed in the western part of the Basin.

Estimates were made of the present use and future needs of water for livestock. Average consumptive use rates from the Missouri River Basin Comprehensive Study were used to estimate total daily requirements for water by livestock. These figures do not include water used by horses or wild animals.

Over 13 million gallons of water were used daily by livestock in 1960 (Table 43). Projected consumptive use of water was estimated on the basis of earlier projections of livestock production requirements. The rates of water

use per head is assumed to remain the same in the future. By 1980 the use of water for consumption by livestock is expected to increase by about 30 percent. By the year 2020, consumptive needs for livestock are expected to increase by about 20 million gallons per day.

Table 43. Present and Projected Use of Water by Livestock: South Grand-Osage River Basin, Missouri

Livestock category	Use per head per day	YEAR 1960	1980	2000	2020
		1,000 gallons per day			
Milk cows	30	4,920	5,855	8,020	11,020
All other cattle	12	6,204	8,810	11,974	17,868
Hogs	4	1,492	1,731	2,387	3,312
Sheep	1.5	111	125	204	310
Chickens and broilers	.06	121	204	280	385
Turkeys	.18	171	310	424	587
Total	--	13,019	17,035	23,289	33,482

While a major portion of livestock water supplies will be from farm ponds and wells, some portion of future need can be supplied through community water systems and water supply districts. Use of these sources would increase reliability in drought periods and provide a better quality water to the benefit of livestock production.

G. Municipal and Industrial Water Supply

Municipal water supply, defined for purposes of this section, is a community water supply system serving a municipality of over 5,500 people. Quantities of water required for municipal use over and above that reported as community use under the preceding discussion on Rural Domestic Water Supply are 4,561,400 gallons per day. Municipal water supply provided through these larger systems will serve the cities of Lebanon, Nevada, Clinton, and portions of Greene, Jackson, and Cass Counties receiving service from Kansas City and Springfield.

In addition to the domestic water supply provided through community systems serving both rural and urban communities, it is probable that all the industrial water supply will be provided from the same source. This is particularly true in the upper portion of the Basin. At present, the community systems have been hard pressed to provide system capacity to meet community domestic water supply needs. If the communities, both rural and urban, expect to attract industry, it will be necessary to provide system capacity ranging from 50 to 100 percent above that determined necessary to satisfy domestic use. Very few of the communities in the Basin have the capability to deliver more than 20 to 25 percent above that water necessary for household and fire protection requirements. Based on the above, there is a need to develop or expand water supply sources that could deliver an additional 6,800,000 gallons per day for industrial use. Water supply for existing forest industry is adequate until 2020, unless a pulp mill locates in the Basin.

In general, surface water sources or treatment of ground water to obtain desirable quality should be considered by communities in the upper Basin. Additional wells, properly spaced, can provide for the industrial water supply requirements in the lower Basin.

Multiple-purpose reservoirs are needed for water supply, recreation, and flood control.

H. Recreation

The needs for recreational facilities for the population and the immediate standard metropolitan statistical areas were evaluated using a computerized econometric model. The needs cover the five basic activities: boating, camping, fishing, swimming and picnicking. A need was determined for reservoirs that will provide approximately 1.7 million recreation days for 1980, increasing to 2.7 million in 2000, and to 3.2 million for the year 2020. Much of this need is for day use with easy accessibility to population centers. To fulfill these needs will require 9,300 acres of water and 23,900 acres of land for recreational facilities (Table 44).

Table 44. Recreational Areas Needed: South Grand-Osage River Basin, Missouri

	1980	2000	2020
Land (Acres)	12,100	22,300	23,900
Water (Acres	5,000	8,700	9,300

Photo by: Walker-Missouri Tourism

Day use, water-oriented, recreational opportunities are needed near population centers.

I. Fish and Wildlife

Hunting and fishing activities are expected to increase. Although much of the demand will continue to be met on private lands, there will be a need during the next few years for at least 20 stream access sites, 4 additional fishing lakes, 13 public hunting areas, and several additional waterfowl management areas.

Protection of high quality, spring-fed Ozark streams through designation as scenic rivers is under discussion in Missouri. The Niangua River is a prime candidate for such designation. Of equal importance is the optimization of recreation opportunities and retention or improvement of fish and wildlife habitat in the development and use of all streams and impoundments within the Basin. Coordinated planning by all interests can result in development of programs and projects capable of protecting the environment and enhancing the overall resource base.

Strip mining in the western portion of the Basin has altered the face of about 25,000 acres of land. Some of these areas when properly mined and reclaimed provide valuable additions to the fish and wildlife habitat. Other mined areas remain virtual biological deserts for long periods of time. Reclamation could contribute more immediate benefits to fish and wildlife if

mining companies were required to utilize methods which reduce pollution of land and water. Such measures could be in the form of cooperative efforts by State, Federal, and company officials or by State or Federal legislation.

Photo by: Walker-Missouri Tourism

Protection of high quality, spring-fed Ozark streams and the reclamation of strip-mined areas are needed for improvement of fish and wildlife habitat and recreational opportunities.

After Kaysinger Bluff Reservoir is complete, large impoundments will total 160,000 acres. It is imperative to coordinate the operation of impoundments with good fishery management practices to optimize the public return in fishery benefits. Fishing opportunity could be enhanced also by requiring public access as a condition for construction on any public-financed impoundments.

J. Rural Power

Based on past experience, the Rural Electrical Cooperatives served by REA indicate that power consumption will double every eight to ten years. Cooperatives serving the Stockton and Kaysinger Bluff Reservoir areas will lose customers during the construction of the reservoirs. However, they and Cooperatives serving the area around the Lake of the Ozarks and Pomme de Terre expect total consumption to increase (Table 45).

Table 45. Electric Power Requirements: South Grand-Osage River Basin, Missouri

Description	Unit	1960	1968	1980 1/
Meters	Number	50,000	58,000	70,000
Line energized	Mile	17,400	18,600	21,000
Consumption	KWH/Meter/Mo.	280	528	1,000
TOTAL Consumption	(1,000) KWH/Yr.	14,100	30,132	70,000

1/ Estimated

Source: Electrical Cooperatives

K. Water Quality Control

The major source of pollution of surface water in the Basin is sediment originating from agricultural lands, construction practices, and streambank erosion. The apparent solution to this problem would be: application of soil conservation practices on farms; control of construction practices; reestablishment of proper vegetative cover; and, in some instances, streambank stabilization.

Pollution by municipalities and industry is regulated by the Missouri Water Pollution Board. All municipalities and industry, except the city of Osceola, have provided adequate treatment or are in the process of expanding treatment facilities. Osceola has not improved its treatment plant because of the uncertainty of relocation that will be necessitated by construction of Kaysinger Bluff Reservoir. Although Big Creek does not need low-flow augmentation now, the continued urbanization and industrialization of the watershed could cause quality problems during low flows. Feedlots, also regulated by the Board, may be a problem in the future.

Some potential deterioration of water quality may occur locally from abandoned strip mining operations, and reclamation of the mined area may be necessary. Future mining operations should be carried out with proper reclamation and drainage to prevent acid and other pollutants from entering streams.

VI. EXISTING WATER AND RELATED LAND RESOURCE PROJECTS AND PROGRAMS

The many State and Federal agencies supply services to meet resource conservation needs in the Basin. Although the programs of these agencies are comprehensive, the present level of operation in manpower and funding is below present development requirements. Discussion of these programs follows.

A. USDA Programs

The PL-46 Program includes activities authorized under the Soil Conservation Act (Public Law 46, 74th Congress 1935). The Soil Conservation Service under PL-46 carries on a broad program of soil and water conservation operations including direct assistance to land owners and operators and technical services to other agencies and organizations.

The primary job of the Soil Conservation Service is helping land owners and operators, individually or in groups, do conservation work on the land. Such work is basic to, and is a necessary foundation for, watershed protection and other soil and water conservation activities in both rural and urban areas. Related activities include soil surveys and soil investigations, helping find and improve plant materials for conservation uses, and providing technical services in connection with other USDA programs involving financial or other assistance in conservation work.

Assistance to Soil and Water Conservation Districts and other qualified sponsors is available for developing group action programs through the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, as amended). Applications and project plans must be approved by the Government. Applications have been submitted on Little Drywood and Cedar-Horse Creek Watersheds. Authorization for planning these watersheds has not been requested.

In 1962, Congress passed the Food and Agriculture Act (Public Law 87-703) which authorized the organization of Resource Conservation and Development projects. This program authorizes technical, financial, and loan assistance to legal sponsors in approved areas where acceleration of going resource conservation programs will increase economic opportunity for local people. Resource Conservation and Development projects provide local leadership with the opportunity to coordinate and use local, State, and Federal facilities more fully in developing and carrying out a plan of action for the orderly conservation improvement and development and wise use of natural resources. The Southwest RC&D Project, which includes Cedar County and parts of Barton and Dade Counties, is currently active.

The Agricultural Stabilization and Conservation Service program provides cost-sharing to farmers in implementing soil, water, woodland, and wildlife conservation practices on farmlands now in agricultural production. The program also provides aerial photos for conservation work and planning assistance for land measurement, residential and industrial development, and emergency measures for natural disasters. Any owner or operator of farmland is eligible to apply for cost-sharing. Special Agricultural Conservation Programs are available on community-organized practices as well as on individual farms.

Credit assistance is available from the Farmers Home Administration. This includes: (1) farm ownership loans, (2) farm-operating loans, (3) farm emergency loans, (4) loans for housing, both rural and urban, (5) loans for grazing associations, and (6) loans to develop rural recreation enterprises. Loans for water and waste disposal systems are available for rural districts or towns and villages.

The Federal Extension Service is part of the cooperative extension service partnership. Three levels of government -- Federal, State, and County share in financing, planning, and carrying out extension educational programs. Extension Service acts as the education agency of the U. S. Department of Agriculture and the land grant universities. Extension specialists work with other agencies to provide local people information relating to soil and water conservation programs. This work has been an integral part of USDA since 1914, when the Smith-Lever Act became law.

Cooperative Federal-State forestry programs active within the Basin include: Forestation, Forest Management, Insect and Disease Control, and Fire Control. The various services of these programs are provided through the Missouri Department of Conservation, Division of Forestry. Cost-sharing is available through the Agricultural Conservation Program for approved forest practices installed on private land. The Forest Service is cooperating with the State and the Corps of Engineers in multiple-use planning of public use areas and implementation of such plans on certain reservoir sites, including Pomme de Terre, Stockton, and Kaysinger Bluff Reservoirs.

Over 99 percent of the commercial forest land is in private ownerships, and two out of every three of these areas are in small holdings. Forestry programs in which the State and the U. S. Forest Service cooperate are largely directed to helping these small, private forest landowners plant, grow, protect, and market their timber. It is estimated that there is a total of 22,964 forest-land ownerships of which 19,137 are resident owners and 3,827 are absentee owners.

Many cooperative programs are well established and represent some progress. During 1955-66, 388 landowners received management planning assistance under cooperative forestry programs involving a total of 72,531 acres. Other accomplishments included: Tree planting on 1,919 acres of open lands, stand improvement (including reenforcement planting) on 3,202 acres of forest land, improvement and controlled harvest cutting on 12,945 acres, and 48,330 acres protected from grazing. Under these programs, an additional 2,860 acres of tree planting, 19,240 acres of stand improvement, and 62,790 acres of grazing control are projected for completion by 1980.

B. Corps of Engineers' Projects

Authorized Corps of Engineers' projects are: the Pomme de Terre Reservoir, Stockton Reservoir, Kaysinger Bluff Reservoir, and Hackleman Corner Reservoir. All are either under construction or have been built, except Hackleman Corner which has been deferred.

Pomme de Terre Dam was completed and placed in operation in 1961. The dam is located three miles south of Hermitage in Hickory County, Missouri.

The reservoir has a gross capacity of 650,000 acre-feet and controls a drainage area of 611 square miles. Flood protection is provided to more than 7,000 acres along the Pomme de Terre River and downstream areas along the Osage, Missouri, and Mississippi Rivers. The flood control benefits are estimated at $485,000. The conservation pool forms a lake of about 7,820 acres, providing 590,000 visitor days of recreation yielding annual benefits of $384,000. In addition, there are downstream power benefits of $22,000 and $64,000 navigation benefits.

Photo by: Walker Missouri Tourism

Pomme de Terre - a multiple use flood control and recreation reservoir.

The Stockton Dam is located on the Sac River, a tributary of the Osage River, in Cedar County about two miles east of Stockton. Construction was started in the fall of 1963. The reservoir will have a gross capacity of 1,674,000 acre-feet and controls a drainage area of 1,160 square miles. The multiple-purpose reservoir provides annual flood control benefits of $874,000. It provides protection to about 19,300 acres along the Sac River above the Kaysinger Bluff Reservoir area and joint protection to lands along the Osage, Missouri, and Mississippi Rivers. The conservation pool, with a surface area of 24,900 acres, will provide annually 1.5 million visitor days of recreation with benefits of $1,085,000. On-site power benefits are estimated at $514,000 and downstream power at $334,000 annually from the operation of Kaysinger Bluff and Bagnell Dams.

The Kaysinger Bluff Dam is located on the Osage River less than one mile upstream from Warsaw, Missouri, at the headwaters of the Lake of the Ozarks. Construction was initiated in the fall of 1964. The reservoir has a gross

capacity of 5,202,000 acre-feet. Its total drainage area is 11,174 square miles of which 7,856 square miles is uncontrolled drainage area below other authorized Corps of Engineers' reservoir sites. Flood control benefits of $4,821,000 annually result from providing flood protection to the resort and recreational areas along the shores of the Lake of the Ozarks and joint protection to lands along the Osage, Missouri, and Mississippi Rivers. Included in the flood control benefits are downstream power benefits from Bagnell Dam and navigation benefits on the Mississippi River. The 55,600-acre lake will provide two million annual visitor days of recreation with benefits of $1,300,000. Power benefits generated at Kaysinger Bluff will amount to $1,240,000 annually.

The Upper Osage preliminary report of the Corps of Engineers, dated September 1967, proposed developments on the Big Creek land protection improvement near Pleasant Hill, Missouri, and the Freeman, East Branch, Butler, and Nevada Reservoirs.

The Department of the Army, Corps of Engineers, Kansas City District, has initiated a survey for flood control improvements on the lower reaches of the Osage River below Bagnell Dam. The survey, started in 1968, is being coordinated with USDA and will consider Public Law 566 watershed potential for damage reduction as identified in this report before recommendations are made.

C. Federal Defense Lands

Camp Clark contains two sections of land, half of which is State-owned; the remainder is licensed to the State by the Federal Government. This camp has been used for many years as a training site for the Missouri Army National Guard. It is used for annual field training, maintenance, and storage; and it is the training site for the State Officers Candidate School and is used for weekend training by many other units of the Mo ARNG.

The Nike-Hercules surface-to-air missile site in the Kansas City defense area, located near Lone Jack, is supported 100 percent with Federal funds. It is manned 24 hours a day, seven days a week as an integral part of the national air defense system.

The missile complex headquartered at Whiteman Air Force Base near Knob Noster has sites scattered over a great area of the northeastern section. These are connected by an underground cable system. Measures were taken along these routes to protect against soil erosion.

D. State Programs

The State Forestry Act is one of the most important aids to the practice of forestry in Missouri. The act, passed in 1946, is designed to minimize the major obstacles which have stood in the way of a private owner of timber land who wished to manage his land for timber production and for the related benefits of erosion control, recreation, wildlife and watershed protection. The State Forestry Act: (1) Clarifies the State law with regard to burning the woods, (2) Grants the Conservation Commission additional powers in assisting landowners in the enforcement of State trespass laws, (3) Provides for the deferment of a part of the taxes against his forest land and the substitution of a yield tax to be paid at harvest time.

The graduated percentage of payment, four percent for one to ten years, dwindling to no payment after 26 years, provides needed tax relief to induce small owners to protect their forest land from grazing and wildfire and to manage the stands for optimum timber production.

The Missouri Department of Conservation over the years has made an effort to assure public fishing and hunting opportunity where it is not otherwise available. Present holdings of the department are shown in Table 46.

Table 46. Land and Water Areas Owned by the Missouri Department of Conservation: South Grand-Osage River Basin, Missouri

County	Number of Areas	Total Acreage	1968 Type Areas		
			Fishing	Hunting	Other
Jackson	1	2,151	X	X	
Bates	1	299	X	X	
Vernon	2	4,825	X	X	X (1)
Henry	3	1,400	X	X	
St. Clair	2	5,573	X	X	X (1)
Cedar	2	320	X *	X	
Lawrence	1	119			X (2)
Benton	3	2,042	X	X	
Hickory	1	2	X *		
Polk	2	1,423		X	
Morgan	3	477	X	X	
Dallas	2	1,878	X *	X	
Laclede	2	1,108	X *	X	
Miller	3	83	X *	X	
Cole	2	28	X *		
Osage	1	8	X *		
Total	31	21,736			

* Stream Access
(1) Prairie chicken refuge
(2) Fish Hatchery

Although the Department of Conservation tries to provide public hunting opportunities on department lands throughout the State, the bulk of hunting will continue to be on private lands. Waterfowl hunting is provided at Schell-Osage and Montrose Wildlife Areas in the western part of the Basin. Some waterfowl hunting is available on many public and private lakes, ponds, and rivers scattered across the Basin.

Bennett Springs State Park is not only one of the oldest but is the most popular park in the State. The park, consisting of 730 acres, is located 12 miles west of Lebanon on State Highway 64. The overnight campgrounds have been enlarged and a comfort station, complete with showers and automatic clothes washer and dryer are available. Also, housetrailer parks with connections for water, electricity, and disposal have been added. Other facilities available are: dining lodge, cabins, store, picnic grounds, nature museum

and swimming pool. The outstanding feature of the park is the large volume of clear, cold water from the sixth largest spring in Missouri, with an average daily flow of 71 million gallons.

The Department of Conservation trout hatchery at Bennett Springs State Park provides trout for fishing in the spring branch and the Niangua River below the spring branch. Trout fishermen made 123,257 trips to Bennett Springs in 1968.

The Lake of the Ozarks State Park, located near Osage Beach, is the largest in the Missouri State Park system, containing 16,335 acres. It has 89 miles of shoreline and about 4,000 acres of water. The park includes most of the Grand Glaize Arm of the Lake. Two public swimming and boat-launching areas are provided. Other available recreation facilities are abundant, such as: boating, fishing, picnicking, tent and trailer camping, horseback riding, nature trails, and the six organized group camps--Rising Sun, Clover Point, Hawthorn, Pin Oak, Red Bud, and Pa-He-Tsi. In each of these six organized group camps located on the lake front, an administrative group consists of a camp office, infirmary, staff headquarters, mess hall, recreation hall, swimming, and boat docks. The camper facilities are grouped around the administrative buildings in units consisting of cabins, unit lodge, outdoor kitchen, and unit wash house and latrine.

Photo by: Walker-Missouri Tourism

Camping and swimming are enjoyed at State Parks.

Pomme de Terre State Park is located in Hickory County, five miles south of Hermitage. The 364-acre park has facilities consisting of a modern boat dock with rental boats, outboard motors for fishing or skiing, boat-launching ramp, restaurant, swimming, camping, and picnicking accommodations.

E. Soil Conservation District Program

A Soil and Water Conservation District is a legal division of State Government, directed by a Board of Supervisors elected by the people of the district. It operates under rules of the State's Enabling Act which is administered by the Missouri Soil and Water District's Commission. The supervisors are responsible for directing an action program to implement soil and water conservation programs within the district.

Nineteen counties located all or partially within the Basin have organized districts. The landowners in each district have developed long-range conservation programs based on existing conditions and land treatment needed. The Board of Supervisors prepares an annual calendar of work specifying the objectives for the coming year.

The Districts have requested technical assistance from the Soil Conservation Service through the provisions of the Soil Conservation Act (Public Law 46, 74th Congress, 1935). This technical assistance is then made available to the landowners who are co-operators of the Soil and Water Conservation District to plan and use their land within its capabilities. This technical assistance consists of soil surveys and interpretations, finding and improving plant materials for conservation uses, and providing agronomic and engineering field assistance in applying conservation measures.

F. Projects of Drainage Districts

The history of drainage districts in the Basin began with the formation of the Bates County Drainage Ditch No. 1 in 1910. This ditch provides an improved channel for the Marais des Cygnes River through Bates County, Missouri. It also provides an outlet for over 3,200 square miles of drainage originating in Kansas. The outlet of this ditch forms the Osage River in Missouri. The original bonds were paid in the early 1940's and the District is no longer active.

Two small levee districts are in Bates County that are still active. They are the Lone Oak District and the Athol Levee District. Both are located on the lower reaches of Miami Creek which outlets into the Marais des Cygnes River.

Big Creek Drainage District No. 1 was organized in 1911 with an improved channel on Big Creek starting in Johnson County and extending into Henry County. The last record of maintenance was May 1968, and before that in March 1946. The District is no longer active. In January 1949, the Cass County Big Creek Drainage District No. 1 was formed in the upper reaches of Big Creek. No construction work was ever started in this district.

The Grand River Drainage District in Cass and Bates Counties was organized in about 1913. The original bonds were retired in the early 1940's.

The District was revived in October 1964 and is active in collecting taxes and providing maintenance. The ditch was extended into Henry County by the Pioneer Drainage District. This district is inactive; and no maintenance is provided, which reduces the effectiveness of the project. At one time, the total benefited area in drainage districts was 85,380 acres.

G. Significant Water Resource Development of Cities, Counties, and Private Enterprise

Historically, the development of water resources has been by local political subdivisions, by utility companies, and by private enterprise. The permissive-type laws, applicable in Missouri, have encouraged this course of resource control and development. In the last three decades, Federal resource programs have recognized and encouraged development in the national interest. However, a major portion of existing water resource development is the result of local initiative and investment to meet locally recognized problems. Areas of local involvement, both public and private, include hydropower generation, municipal water supply, sewage treatment and recreation facilities.

Hydroelectric development by public utilities includes Bagnell Dam, Osceola Dam on the Osage River, and Tunnel Dam on the Niangua River. Table 47 shows the ownership, capacity and generation of these installations.

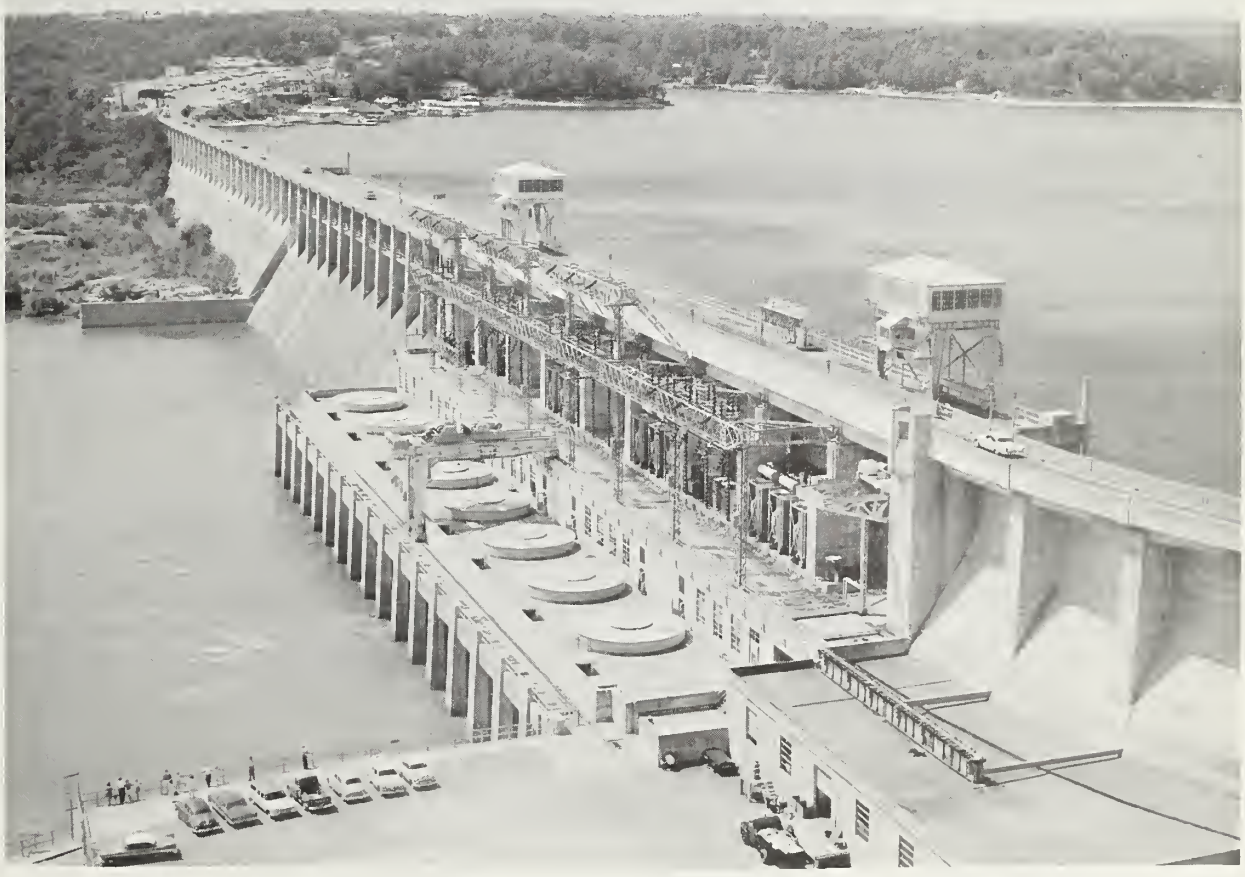


Photo by: Walker-Missouri Tourism

Bagnell Dam - a private hydroelectric development creating the Lake of the Ozarks.

Table 47. Water Power: South Grand-Osage River Basin, Missouri

Name	Installed Capacity (Kilowatt)	Average Annual Generation (Kilowatt-hours)
Missouri Public Service Co. Osceola Dam 1/	1.6	7,000
Sho-Me Power Coop. Tunnel Dam	3.0	13,000
Union Electric Co. Bagnell Dam	172.0	440,000

1/ The Osceola Dam will be operated until Kaysinger Bluff Reservoir inundates the installation.

Municipal water for drinking and other purposes, approved by the State Board of Health, is supplied to the Basin population through some 114 systems. Of these systems, the source of supply is as follows: Ground - 68, Surface - 17, and Other (purchases from major cities, water districts, etc.) - 29.

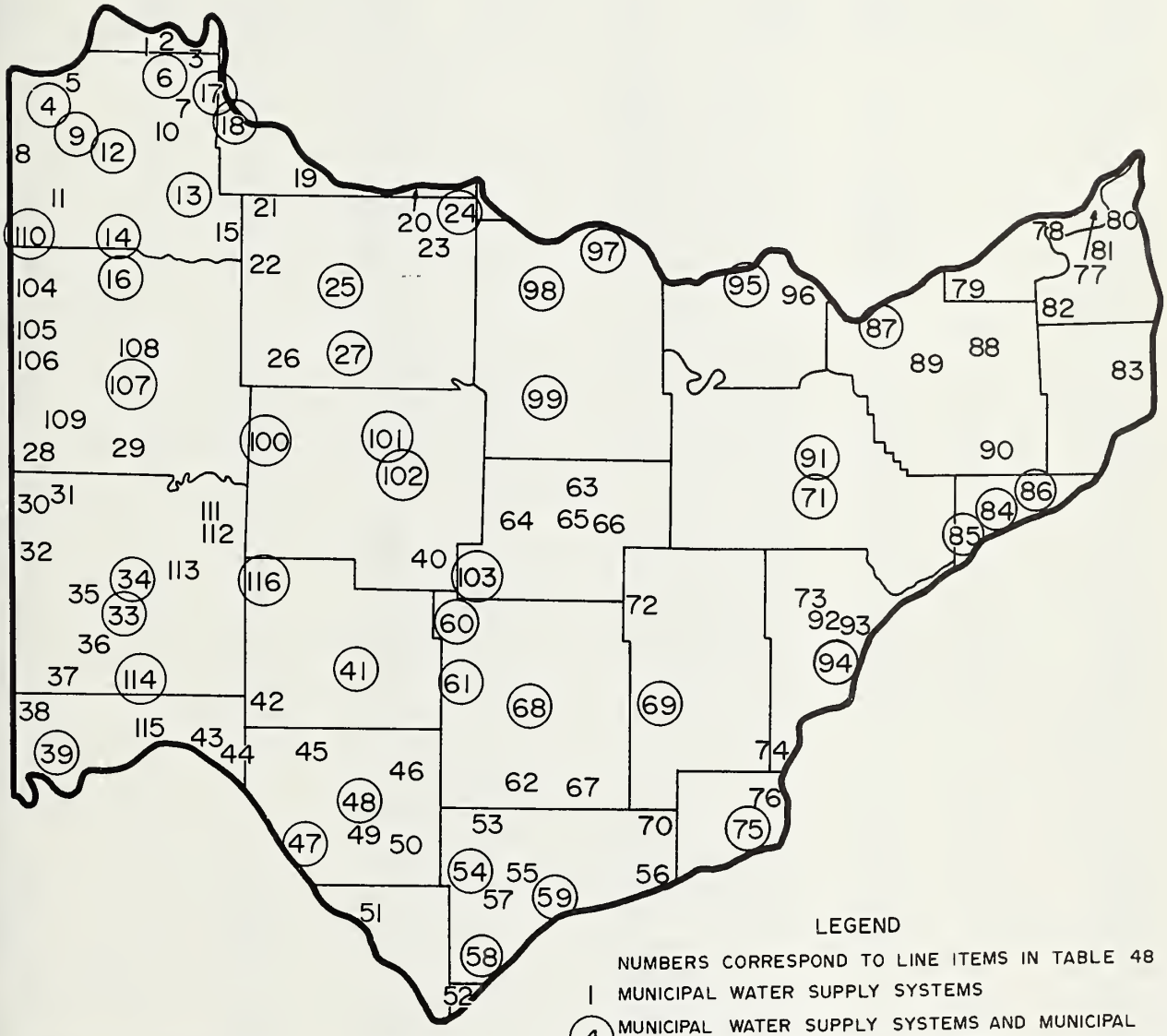
Sewage treatment is by one primary and 44 secondary treatment plants. These facilities, representing the study area and possibly some cities on the border-line, have a combined design capacity of 173,868 Population Equivalent and serve 95,221 people. The location and capacity of existing water and sewage works are shown on Map No. 14 and Table 48.

Private enterprise, primarily through individual initiative, has developed a major portion of the recreational lands and facilities within the Basin.

Privately owned resorts, restaurants, supply outlets and access to the water surface of the Lake of the Ozarks result in a recreational area of national importance. Fishing camps on streams and boat rental services contribute to the overall balance of water-oriented recreational opportunities now existing.

Lake construction by private corporations provide both vacation and permanent homesites having associated water-oriented recreation benefits. Generally, these are located near Kansas City or other populated centers. These real estate developments create community-type living by providing streets, water and sewer facilities, and electricity in a controlled environment featuring open space and outdoor recreation opportunities.

MAP 14: LOCATION OF MUNICIPAL WATER SUPPLY SYSTEMS AND MUNICIPAL WASTEWATER TREATMENT FACILITIES
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



SOURCE: MISSOURI WATER POLLUTION BOARD
MISSOURI DIVISION OF HEALTH

Table 48. Municipal Water Supplies and Sewage Treatment Facilities, November 30, 1969: South Grand-Osage River Basin, Missouri

City and Subbasin	Map No.	Population 1960	MUNICIPAL WATER SUPPLIES				WASTE TREATMENT FACILITIES			
			Population Served	Source	Plant Capacity MGD	Average Consumption MGD	Population Served	Treatment Type	Treatment Rating	Designed Capacity Popula. Equiv.
SOUTH GRAND										
Greenwood	1	488	500	Lee's Summit Jackson #12		2.700				
Lee's Summit	2	8,276	19,000	Kansas City & Indep.		1.446				
Lone Jack	3	180	180	Surface	0.101	0.009				
Belton	4	4,897	6,000	Kansas City		0.300	4,000	S	A	5,700
Raymore	5	268	380	Surface	0.100	0.020				
Pleasant Hill	6	2,689	2,700	Surface	0.766	0.355	2,400	S	A	6,000
Strasburg	7	213		Cass #1						
Cleveland	8	216	250	Surface	0.036	0.020				
Peculiar	9	458	770	Surface	0.144	0.045	450	S	A	596
East Lynne	10	243	220	Ground	0.072	0.009				
Freeman	11	391	525	Surface	0.072	0.040				
Harrisonville	12	3,510	3,800	Surface	0.792	0.450	3,460	S	I	3,000
Garden City	13	600	900	Surface	0.150	0.070	550	S	A	812
Archie	14	348	380	Surface	0.144	0.091	340	S	A	530
Creighton	15	228	200	Ground	0.058	0.020				
Adrian	16	1,082	1,250	Surface	0.230	0.075	1,000	S	A	1,450
Kingsville	17	225	150	Ground	0.022	0.007	200	S	I	294
Holden	18	1,951	2,200	Surface	0.346	0.210	1,800	S	A	2,500
Chilhowee	19	339	440	Ground	0.036	0.020				
Leeton	20	371	500	Ground	0.238	0.020				
Blairstown	21	177	175	Ground	0.036	0.020				
Urich	22	408	387	Ground	0.086	0.025				
Calhoun	23	374	375	Ground	0.216	0.008				
Windsor	24	2,714	2,714	Ground	1.108	0.380	2,700	S	A	3,970
Clinton	25	6,925	7,645	Surface	1.080	0.750	6,800	Sx2	A	25,160
Montrose	26	526	496	Ground	0.043	0.025				
Deepwater	27	712	712	Ground	0.104	0.050	600	S	A	100
LITTLE OSAGE										
Hume	28	369	369	Ground	0.043	0.020				
Rich Hill	29	1,699	1,699	Ground	0.720	0.300				
Stotesbury	30	64		Vernon PWSD						
Metz	31	137		Vernon PWSD						
Richards	32	133		Vernon PWSD						
Nevada	33	8,416	10,500	Ground	3.450	0.800	7,000	S	A	10,000
Nevada St.Hosp.	34						2,700		A	3,000
Deerfield	35	200		Vernon PWSD						
Moundville	36	133		Vernon PWSD						
Bronaugh	37	173	173	Ground	0.072	0.016				
Oskaloosa	38	50		Barton #2						
Liberal	39	612	612	Ground	0.430	0.080	600	S	A	1,650
SAC RIVER										
Collins	40	177	177	Ground	0.122	0.008				
Stockton	41	838	900	Ground	0.800	0.100	750	S	A	1,200
Jerico Springs	42	179	175	Ground	0.144	0.007				
Milford	43	90		Barton PWSD #3						
Newport	44			Barton #3						
Arcola	45	135	82	Ground	0.144	0.002				
Dadeville	46	142	142	Ground	0.216	0.007				
Lockwood	47	835	900	Ground	0.288	0.060	780	S	A	900
Greenfield	48	1,172	1,000	Ground	0.446	0.140	1,050	S	A	5,225
So. Greenfield	49	179	179	Ground	0.257	0.005				
Everton	50	261	261	Ground	0.178	0.018				
Miller	51	601	630	Ground	0.350	0.060				
Billings	52	602	590	Ground	0.598	0.030				

Table 48. Municipal Water Supplies and Sewage Treatment Facilities, November 30, 1969: South Grand-Osage River Basin, Missouri

(Continued)

City and Subbasin	Map No.	Population 1960	MUNICIPAL WATER SUPPLIES: Population Served	Source	Plant Capacity MGD	Average Consumption MGD	WASTE TREATMENT FACILITIES: Population Served	Treatment: Type	Treatment: Rating	Designed Capacity Popula. Equiv.
Walnut Grove	53	373	373	Ground	0.200	0.050				
Ash Grove	54	886	710	Ground	0.504	0.125	870	S	A	1,600
Willard	55	357	357	Ground	0.288	0.035				
Strafford	56	300	300		0.245	0.035				
Bois D'Arc	57	350		Greene PWSD #6						
Republic	58	1,519	1,650	Ground	1.210	0.200	1,000	S	A	2,150
Springfield	59	95,865	125,000	Surface	24.000	10.000	23,000	S	A	30,000
Humansville	60	745	745	Ground	0.583	0.140	675	S	A	2,650
Fair Play	61	335	335	Ground	0.250	0.045	300	S	A	535
Morrisville	62	228	228	Ground	0.072	0.011				
POMME DE TERRE										
Cross Timbers	63	186	180	Ground	0.173	0.002				
Wheatland	64	305	300	Ground	0.144	0.015				
Hermitage	65	328	328	Ground	0.144	0.050				
Preston	66	117		Hickory #1						
Pleasant Hope	67	216	216	Ground	0.216	0.011				
Bolivar	68	3,512	3,512	Ground	3.053	0.550	3,230	S	A	5,178
Buffalo	69	1,477	3,000	Ground	0.792	0.175	1,220	S	A	1,600
Fair Grove	70	300		Greene #5						
NIANGUA										
Camdenton	71	1,405	1,400	Ground	0.798	0.250	1,350	Sx5	A	4,180
Urbana	72	348	350	Ground	0.200	0.015				
Eldridge	73	100		Laclede #1						
Conway	74	500	514	Ground	0.216	0.035				
Marshfield	75	2,221	2,200	Ground	1.728	0.240	2,000	S	A	4,500
Niangua	76	287	287	Ground	0.120	0.077				
OSAGE										
Osage City	77	275		Cole PWSD #1						
Wardsville	78	100	100	Ground	0.120	0.008				
Eugene	79	151	200	Ground	0.120	0.015				
Loose Creek	80	200		Osage PWSD #1						
Westphalia	81	316		Osage PWSD #2						
Meta	82	360	400	Ground	0.360	0.030				
Argyle		99		(Proposed Water Supply)						
Vienna	83	536	525	Ground	0.120	0.025				
Crocker	84	821	850	Ground	0.240	0.085	400	S	A	1,200
Richland	85	1,662	2,000	Ground	0.492	0.100	1,600	S	A	3,800
Dixon	86	1,473	2,100	Ground	0.828	0.150	1,500	S	A	2,835
Eldon	87	3,158	3,400	Ground	1.030	0.600	262	Sx2	A	270
St. Elizabeth	88	57	57		0.144					
Tuscumbia	89	231	27	Ground	0.029	0.002				
Iberia	90	694	900	Ground	0.240	0.067				
Linn Creek	91	174	160	Ground	0.045	0.011	110	S	I	200
Dove	92			Laclede #1						
Sleeper	93			Laclede #1						
Lebanon	94	8,820	8,250	Ground	2.660	0.900	9,000	S	A	12,000
Versailles	95	2,047	2,200	Ground	0.720	0.216	125	S	A	470
Barnett	96	200	210	Ground	0.192	0.016				
Cole Camp	97	853	811	Ground	0.720	0.047	500	S	A	1,200
Lincoln	98	446	500	Ground	0.768	0.050	486	S	A	954
Warsaw	99	1,054	1,150	Ground	0.576	0.180	945	S		3,500
Appleton City	100	1,075	750	Surface	0.288	0.072	1,100	S	A	1,325
Lowry City	101	437	398	Ground	0.137	0.025	400	S	A	610
Osceola	102	1,066	1,066	Ground	0.090	0.075	460	P	I	X
Weaubleau	103	349	350	Ground	0.210	0.010	300	S	A	600
Merwin	104	76		Bates PWSD #2						
Amsterdam	105	118		Bates PWSD #2						

Table 48. Municipal Water Supplies and Sewage Treatment Facilities, November 30, 1969: South Grand-Osage River Basin, Missouri

(Continued)

City and Subbasin	Map No.	Population 1960	MUNICIPAL WATER SUPPLIES				WASTE TREATMENT FACILITIES			
			Population Served	Source	Plant Capacity MGD	Average Consumption MGD	Population Served	Treatment Type	Treatment Rating	Designed Capacity Popula. Equiv.
Amoret	106	261	250	Surface	0.015	0.046				
Butler	107	3,791	3,791	Surface	1.800	0.440	3,500	S	A	7,600
Passaic	108	84		Bates #6						
Foster	109	153		Bates PWSD						
Drexel	110	651	800	Surface	0.216	0.045	680	Sx2	A	904
Shell City	111	343	403	Ground	0.144	0.015				
Harwood	112	89		Vernon PWSD #3						
Walker	113	235	238	Ground	0.052	0.010				
Sheldon	114	434	434	Ground	0.216	0.050	428	S		1,060
Irwin	115	75		Barton PWSD #1						
Eldorado Spgs.	116	2,864	3,000	Ground	1.640	0.300	2,600	S	A	10,860

S - Secondary Sewage Treatment (Approx. 85% to 90% P.E. Reduction)
P - Primary Treatment (Approx. 35% P.E. Reduction)
A - Adequate Sewage Treatment
I - Inadequate Sewage Treatment

H. Rural Electrification

Electricity is provided to rural areas through 12 electric cooperatives. In 1968, 18,600 miles of line were energized, which served 58,000 customers an average of 528 kilowatt-hours per month for a total consumption of over 30 million kilowatt-hours. A list of the cooperatives serving the Basin is shown in Table 49.

Table 49. Electric Cooperatives: South Grand-Osage River Basin, Missouri

Name	Location
Barton County Electric Cooperative, Inc.	Lamar
Central Missouri Electric Cooperative	Sedalia
Co-Mo Electric Cooperative, Inc.	Tipton
Gascosage Electric Cooperative	Dixon
Laclede Electric Cooperative	Lebanon
Osage Valley Electric Cooperative Assn.	Butler
Ozark Electric Cooperative	Mount Vernon
Sac-Osage Electric Cooperative	El Dorado Springs
Southwest Electric Cooperative	Bolivar
Three Rivers Electric Cooperative	Linn
Webster Electric Cooperative	Marshfield
West-Central Electric Cooperative, Inc.	Higginsville

I. Other Resource Development Programs

The Ozarks Economic Development Region, designated under Title V of Public Law 89-136, the Public Works and Economic Development Act of 1965, has been established to plan for and assist in the initiation of sustained economic development. The designated area includes parts of Arkansas, Kansas, Missouri, and Oklahoma. The Missouri portion includes 44 counties in the southern part of the State, 17 of which are all or partly in the Basin (Map 15).

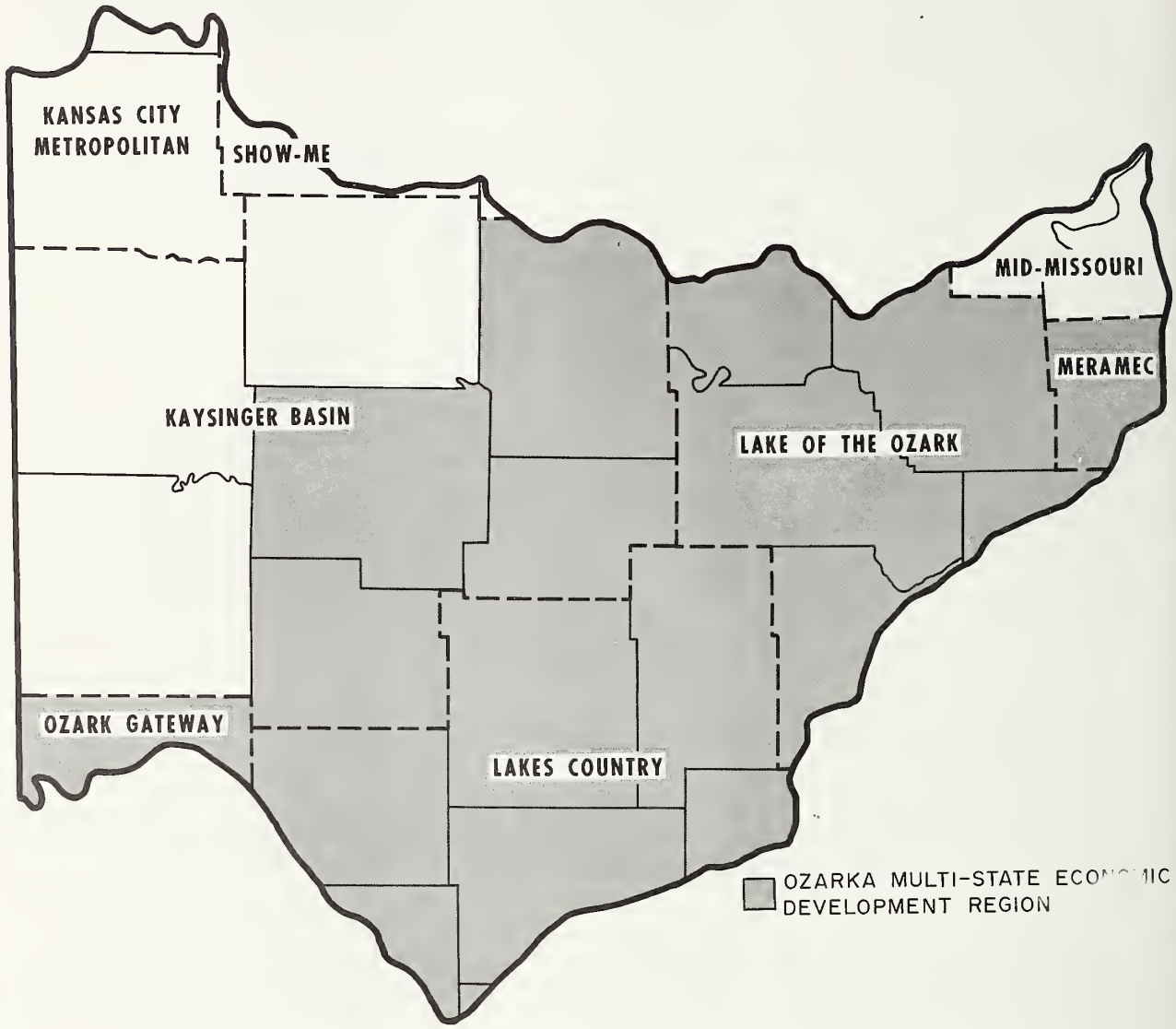
The implementation of the plan would aid in accelerating the economic growth of the study area. The jobs created and resulting income will be net additions to the area economy.

The State and Regional Planning and Community Development Act of 1966 was enacted by the 73rd General Assembly of the State of Missouri. The State is divided into 20 regional planning commissions. The Basin includes parts of eight regional planning commissions (Map 15).

The Regional Planning Commissions have a wide range of duties and responsibilities; among them is making and adapting a comprehensive plan for the development of the region. The comprehensive plan shall be made with the general purpose of guiding and accomplishing a coordinated, adjusted, and harmonious development of the region. The plan will, in accordance with existing and future needs, best promote public health, safety, morals, order, convenience, prosperity or the general welfare, as well as efficiency and economy in the progress of development.

MAP 15: MISSOURI REGIONAL PLANNING COMMISSIONS AND MULTI-STATE ECONOMIC DEVELOPMENT REGION

SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



VII. WATER AND RELATED LAND RESOURCE DEVELOPMENT POTENTIAL

The water and land resources of the Basin have the physical potential for development available to solve the identifiable problems and needs. A discussion of the physical as well as the economic potential, where the two are interrelated, follows.

A. Impoundments

In Land Resource Area 112, potential reservoir sites are available for flood prevention and multi-purpose use to meet short-range needs. Engineering development potential was determined on 131 sites (Map 16). Additional sites that would be as economical are not generally available. Most of the investigated sites have potential storage available for other uses -- municipal and industrial, recreation, irrigation, rural water supply, or water quality control. In addition to project-type, multi-purpose or flood prevention reservoir sites, smaller sites are generally available and could provide storage for fish and wildlife, irrigation, livestock water, rural water supply, and other single purpose uses.

Land Resource Area 116 has a large potential but fewer needs for reservoir storage than LRA 112. The water resource base is generally adequate to provide for anticipated recreational needs. Kaysinger Bluff, Pomme de Terre, and Stockton Reservoirs, the Lake of the Ozarks, the Niangua River, and other spring-fed streams have potential for additional development if access is provided. Good quality and quantity of ground water provide for rural domestic and most municipal and industrial uses. An adequate supply of both ground and surface water is available for irrigation. Good structure sites are generally available, and alternates can usually be located. Sixty-eight potential flood retarding sites were investigated (Map 16); many sites not investigated are available that could be developed if justified. A variety of small, medium, and large sites can provide storage for watershed projects or non-project single purpose uses.

All early-action projects are in Soil and Water Conservation Districts except the Maries Watershed. Although watershed subdistricts have not been organized, they could be developed under a state-enabling act which gives them the power of eminent domain and taxation.

B. Ground Water Developments

The Pennsylvanian formation in the western portion has very little potential to supply ground water for industrial or municipal use. This area will need to develop its water supply from surface water sources or provide extensive treatment to remove dissolved solids.

The Mississippian and Ordovician formations in the eastern section have an ample supply of good quality ground water that can last indefinitely with proper care. This supply is an outstanding asset for industrial, municipal, and rural water supply and can provide water needed for supplemental irrigation. In some areas, casing of wells is necessary for several hundred feet to eliminate pollution.

U. S. DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE

FOREST SERVICE

SOIL CONSERVATION SERVICE

KANSAS CITY
JACKSON
CLAY
PLATTE
CLINTON
CALDWELL
DAVIESS
HARRISONVILLE
JOHNSON
PETTIS
94°
93°
92°
VERSAILLES
JEFFERSON CITY
MISSOURI RIVER
COLE
MORGAN
BENTON
HENRY
ST. CLAIR
BATES
CLINTON
KAYSINGER BLUFF RESERVOIR
BUTLER
WARSAW
LAKE OF THE OZARKS
TUSCUMBIA
OSAGE
MARIES
MILLER
VIENNA
OSCEOLA
HICKORY
HERMITAGE
CAMDENTON
CAMDEN
PULASKI
38°
VERNON
NEVADA
CEDAR
STOCKTON
POLK
DALLAS
BUFFALO
LEBANON
LACLEDE
BOLIVAR
STOCKTON RESERVOIR
DADE
BARTON
GREENFIELD
GREENE
SPRINGFIELD
MARSHFIELD
WEBSTER
LAWRENCE
CHRISTIAN
37°
KANSAS
MISSOURI
EAST BR. BIG CR.
CAMP BRANCH
PANTHER CR
CREEK
SOUTH FK
SOUTH GRAND
EAST BR.
EIGHTMILE CR.
MORRIS CR.
HONEY CR.
FIELDS CR
TEBO CR.
LITTLE TEBO CR.
COLE CAMP CR.
GRAVOIS CR.
MISSOURI RIVER
OSAGE RIVER
MARMATON RIVER
MIAMI CR.
DEER CR.
ELK CR.
WHITEOAK CR.
DEEPWATER CR.
HOGLE
BEAR CR.
WEAUBLEAU CR.
SAC RIVER
BRUSH CR.
LITTLE OSAGE RIVER
MONEGAW CR.
LITTLE NIANGUA RIVER
GRANDGLAIZE CR.
TAVERN CR.
LITTLE MARIES RIVER
MARIES RIVER
GLAIZE CR.
WET AUGLAIZE
DRY AUGLAIZE
LINDLEY CR.
NIANGUA RIVER
POMME DE TERRE RESERVOIR
POMME DE TERRE
LITTLE SAC
TURNBACK CR.
DRY WOOD CR.
CLEAR CR.
ALDER CR.
CEDAR CR.
BEAR CR.
DRY WOOD
MARMATON RIVER
CR.
RIVER
SAC RIVER
GREENE RIVER
WEBSTER

MAP 16

RESERVOIR SITES INVESTIGATED

SOUTH GRAND-OSAGE RIVER BASIN

MISSOURI

LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° AND 45°

SCALE 1/875,000

SCALE 10 0 10 20 30 MILES

SOURCE
SCS DRAWING 5,P-25,309A AND
INFORMATION FROM FIELD TECHNICIANS

4-24-70
5,P-28,112

C. Channel Improvements and Levees

In several areas, primarily in Land Resource Area 112, a potential exists for reducing flooding and improving drainage through channel improvement and levees. This improvement should be considered only in conjunction with flood retarding structures. Levees and channels should not be built without considering their effect on the total flood plain and outlets to adjacent watersheds. In addition, needed straightening and brush removal should be carefully planned to preserve the potential of the area for fish and wildlife. This includes measures necessary to develop cutoff oxbows and cover for wildlife.

The primary purpose of channel improvement is for flood prevention; drainage is secondary. Flood protection can be provided using structures, except where channel capacities are inherently very low or a high level of protection is desired. Then a combination of structures, channel improvements, and levees should be considered. If flooding problems are reduced, drainage systems of lateral ditches and surface channels can be installed to reduce high water tables and remove excess water. Through channel improvement and levees, in 13 reaches of approximately 160 miles of flood plain, a potential exists to provide protection from flooding and to increase crop production efficiency.

D. Irrigation

Potential for the development of supplemental irrigation is excellent. Approximately 2,931,900 acres of land is suitable for irrigation (Table 50). Surface water supply could be developed to irrigate much of this land. The ample ground water supply in Land Resource Area 116 has a high potential for irrigation use.

Table 50. Irrigation Potential - Land Limitation: South Grand-Osage River Basin, Missouri

Land Resource Area	Total	Crop and Pasture	Irrigation Potential
	Acres (000)	Acres (000)	Acres 1/ (000)
112	2,373.6	1,775.7	1,670.8
116	3,990.0	2,003.2	1,261.1
Basin Total	6,363.6	3,778.9	2,931.9

1/ Land suitable for irrigation, limited by soils and slope.

The average volume of runoff leaving the Basin approximates 5,240,000 acre-feet annually. Of this total, LRA 112 discharges 1,640,000 acre-feet while LRA 116 discharges 3,600,000 acre-feet. A net irrigation requirement of 1.5 feet was used to determine the availability of water for potential irrigable acres. Table 51 shows potential areas of irrigation limited by a given percent depletion of average annual runoff.

Table 51. Irrigation Potential - Water Limitation: South Grand-Osage River Basin, Missouri

Land Resource Area	Depletion of Average Annual Runoff			
	Percent			
	25	50	75	100
	(Thousands of acres)			
112	266.6	533.3	800.0	1,066.6
116	600.0	1,200.0	1,261.1*	1,261.1*
Total	866.6	1,733.3	2,061.1	2,327.7

* Limited by availability of land (Table 50).

Although irrigation is currently a marginal investment from an economic net return viewpoint, in many cases, future conditions are expected to be more favorable. High levels of management and low-cost water supplies are a prerequisite to its widespread adoption. As technology and management levels are increased with the adoption of more fertilizer, better seed varieties, and other factors of production, water deficiencies may become the limiting factor. Thus, the complementary relationship between crop technology and irrigation would lead to the need for irrigation water development. No projection has been made for irrigation storage or water use because of these unknown factors.

E. Recreational Developments.

Much of the Basin is endowed with natural resources that appeal to the aesthetic wants of the people.

Two present reservoirs -- Lake of the Ozarks and Pomme de Terre and two reservoirs under construction -- Stockton and Kaysinger Bluff will provide additional water and land for recreational use. However, a need exists for facilities closer to the population centers.

An excellent potential exists for providing additional water and land for recreational purposes. Small reservoirs can provide people with access to high quality recreation developments within a reasonable travel distance.

Recreation potential also exists on privately owned farms. Farm recreation enterprises including vacation farms, shooting preserves, riding stables, campgrounds, and fishing ponds can be made compatible with farm production by proper management of soil, water, plant and animal resources.

To determine the economic potential for recreational developments, all reservoir sites with a physical potential for recreational development were evaluated using an econometric model developed by the University of Missouri. It consists of five demand equations for different types of water-oriented outdoor recreation: 1) Lakes with from 200 to 1,600 surface acres; 2) Lake of the Ozarks; 3) Large lakes such as those constructed by the Corps of Engineers; 4) The Table Rock Complex of several large lakes south of Springfield,

Missouri, on the Arkansas state line; 5) Rivers such as the Current River in South-Central Missouri with facilities for fishing, canoeing, floating, and sight-seeing.

The opportunities of the potential reservoirs for these different types of recreational areas were estimated. The four basic inputs of the model are: 1) Population measures in terms of number of households; 2) Income of households; 3) Location of existing recreation sites with respect to population centers; 4) Location of proposed recreational developments with respect to population centers.

Distance to the existing different types of recreation areas, as well as distance to the proposed recreation site, was considered in evaluating potential sites. Attendance and benefits for the potential sites for the years 1980, 2000, and 2020 were estimated by using the projected population and income figures developed earlier in this report. Higher recreation participation rates associated with higher incomes is assumed to continue in the future.

Population centers within or adjacent to the Basin were used in developing distances to each of the five types of recreation areas. For Kansas City, Springfield and Jefferson City, a point in the middle of the city was used to represent the population center. Within the Basin, centrally located towns were used to represent the population of the entire county.

Each possible reservoir with potential multiple use for recreation and flood control was delineated. The attendance and net recreation benefits of the potential sites for each projected time frame were evaluated. Recreation attendance and benefits for several of the structures were low because of either low population or the close proximity of existing alternative recreational facilities.

All potential sites were analyzed for recreational use; some were dropped from consideration; some were replaced by others closer to population centers; and the size of others was changed to more nearly meet the needs. This resulted in a better system of potential reservoirs for recreational use that would yield higher attendance and greater potential benefits. These reservoirs were then re-evaluated as a complete system for possible recreational development. An evaluation of the final system is made in Chapter IX.

F. Fish and Wildlife Developments

Fish and wildlife resource potentials are influenced directly or indirectly by water and land use. In areas near population centers, the major opportunity for increasing fishing supply lies in the construction of small reservoirs. A greater amount of this demand could be met if public access to more reservoirs were provided, including those constructed under the Public Law 566 Program. Other demand could be met by construction of community-sponsored reservoirs near population centers. Fish and wildlife stream values could be improved by maintaining minimum flows through releases from all reservoirs. Wildlife habitat could be improved by establishing cover and food plot areas on private lands.

On large reservoirs such as Kaysinger Bluff, Stockton, Pomme de Terre, and Lake of the Ozarks, possibilities exist to increase fishing capacity. Of particular importance is assured adequate public access through acquisition and development of special sites or through such means as retention of existing roads and bridges for this purpose. Reservoir zoning would insure that areas are available for all uses with minimum conflicts. All riprapped areas, tailrace areas, and afterbays can offer especially fine fishing opportunities.

The potentials for improving stream habitat for fish and wildlife development center around planned access, elimination of water pollution, and reduction of sedimentation.

The potential for building important goose management areas exists on Kaysinger Bluff and Stockton Reservoirs which are under construction. Private lands would offer hunting opportunities if public access were granted by land owners. Another potential is the conversion of land with other uses to wildlife areas. This is especially needed to replace wildlife habitat destroyed by drainage, overgrazing, inundation, intensive agriculture, and stream straightening.

G. Water Quality Control

The greatest potential for improving water quality in most streams in the Basin is through control of pollutants at their source. Effective erosion control measures applied on the land would significantly reduce the sediment load in the streams. These measures along with the proper use of fertilizers, insecticides, and herbicides would reduce the possibility of contamination. Low-flow augmentation on Big Creek would help alleviate anticipated quality problems associated with urban expansion.

H. Land Treatment and Adjustments

The use of land according to its capability would result in converting 116,000 acres of Class I land to more intensive use and the changing of 68,400 acres of Class VI, VII and VIII now in cropland to less intensive use.

The potential area of land treatment is 73 percent of the cropland in Land Resource Area 112 and 52 percent of the cropland in LRA 116. On pasture, the potential area of land treatment is 78 percent in LRA 112 and 85 percent in LRA 116. The land treatment measures having the largest potential are terraces, diversions and stripcropping on 43 percent of the cropland and improved cover or reestablishment of grasses on 45 percent of the pasture. Table 52 shows the potential land treatment measures by land resource areas.

Although the forest resources in the Basin are shrinking, the degree of watershed protection and the productive potential of the remaining forests can be increased to offset the loss.

The exclusion of livestock grazing on 1.1 million acres of grazed forest land and the planting of nonstocked or poorly stocked forest will improve the hydrologic condition. The hydrologic condition of the bulk of this area could be improved from very poor to good. Included in this category is the reduction of erosion on 93,680 acres of forest land considered as critical area.

Table 52. Potential Land Treatment Measures: South Grand-Osage River Basin, Missouri

Conservation Treatment Practices	LRA 112 Acres	LRA 116 Acres	Total Acres
Cropland			
Annual cover	70,100	42,100	112,200
Rotation meadow	80,100	58,100	138,200
Contour farming	12,800	2,500	15,300
Terraces, diversions, stripcropping	597,800	391,400	989,200
Permanent cover	44,500	53,500	98,000
Drainage needed	68,600	22,500	91,100
Subtotal	873,900	570,100	1,444,000
Adequately treated	322,900	517,400	840,300
Total Cropland	1,196,800	1,087,500	2,284,300
Pasture			
Protect from overgrazing	72,800	78,400	151,200
Improvement of cover	164,500	95,700	260,200
Brush control	24,100	62,600	86,700
Reestablishment of cover	110,000	296,100	406,100
Brush control and reestablishment	80,300	240,900	321,200
Subtotal	451,700	773,700	1,225,400
Adequately treated	127,200	142,500	269,700
Total Pasture	578,900	916,200	1,495,100
Forest			
Grazing control	185,000	904,700	1,089,700 1/
Planting - open	80,000	20,000	100,000
Planting - forest	98,620	377,400	476,020
Erosion control (Log roads & skid trails)	1,380	10,600	11,980
Subtotal	365,000	1,312,700	1,677,700
Adequately treated	59,300	501,900	561,200
Total Forest	424,300	1,814,600	2,238,900 2/

1/ Reflects area needing fencing. An additional 410,000 acres of forest land would receive needed protection as the result of a management decision.

2/ Excludes 86,300 acres of non-commercial forest lands.

Forest sites vary in productivity as does crop and pasture land. Approximately 600,000 acres of forest land is in poor sites, 1,217,000 acres in medium sites, and 126,900 acres in good sites. Intensive forest management on the medium and better sites could improve the stocking levels.

Some of the bottomland will not be feasible to protect from flooding. This land would have a potential for high production of forest products under intensive management. These forest crops such as black walnut and pecan would not be as susceptible to flood damage.

I. Availability of Land

The projected agricultural production requirements of food and fiber, given in Figure 7, page 48, can be met with the projected agricultural land base with or without the proposed development program. The increased use of land for urban developments, roads, and project developments is expected to reduce land available for agriculture and commercial forestry. This increase is expected to be about 244,800 acres in 1980 and 355,800 acres in 2020. Lands lost to agricultural production from project development include 154,300 acres for Kaysinger Bluff, 40,000 acres for Stockton, and 43,000 acres for the early-action projects, 21,500 acres of which will be needed by 1980. About 94,500 acres will be water areas providing benefits to recreation, municipal and industrial uses, and power. Flood protection to agricultural lands below these structures would result in increased productivity that would more than compensate for the loss of production on land used for structures. Urban expansion and roads are expected to take 29,000 acres by 1980, and an additional 111,000 acres by the year 2020.

Most potential structure sites are presently in agricultural or forestry uses and are generally available for use as water storage areas. However, many of these sites are adjacent to the Kansas City metropolitan area and are in danger of being preempted by urban development.

The forest resources are in a constant state of flux. Withdrawals of commercial forest land for non-forest uses will amount to approximately 230,000 acres by 2020. Non-commercial forest land is expected to increase considerably from the present 86,300 acres. This gain will result from the reservation of commercial forest land for public parks and recreation areas.

A portion of the production lost as a result of the projected decrease in forest land can be replaced by the utilization of land which is flooded frequently and that is not feasible to protect, and areas disturbed by strip mining. A high percentage of these areas could be converted to walnut or pecan production.

Management criteria on plantations to be managed for nut and wood fiber production will vary appreciably from those developed for timber production alone. Investment return, however, will begin at an earlier date as a result of nut production.

In addition to early returns from nut crops, beginning at age 10 and continuing to rotation age when the trees could be cut, the plantations also can be managed for limited grazing.

Although pecan production was not covered in detail, the investment potential both from nut production and from high quality veneer production roughly parallels that of black walnut.

Photo by: Woolridge - Missouri Department of Conservation

Plantations managed for nut and veneer production have a potential on frequently flooded bottomlands and strip-mined areas.

Christmas tree production also exhibits an excellent potential for a short-term forestry investment. Land not suited to crop or forage production can be converted to this use. Several enterprises located in or near the Basin indicate that returns are excellent. Intensive management including pruning, shearing and fertilization can in five to seven years produce a high quality Christmas tree returning $1 to $1.50 per foot in the Kansas City, Jefferson City, Columbia, or Springfield markets. Most of the cultural activities can be carried out by the landowners.

VIII. OPPORTUNITIES FOR DEVELOPMENT OF USDA PROGRAMS

This chapter presents the opportunities available for solving identified problems and for meeting anticipated needs within the Basin, through the application of programs administered by the United States Department of Agriculture. The initiative required for using USDA resources generally rests with individual landowners. Land treatment measures such as contour farming, terraces, waterways, or drainage of cropland; protection from overgrazing or brush control on pasture; and hydrologic stand improvement or grazing control on forest land can be accomplished only when the landowner is motivated to do so. Other measures such as flood control, municipal and industrial water supply, or recreational structures require group or community action. Land treatment measures such as contour farming, protection from overgrazing or exclusion of grazing are aimed at providing specified watershed protection. The others are intended to increase the productive potential of the land. All the measures, when combined with a structural program, provide an integrated watershed management program. Some USDA programs which were conceived to solve special problems also contribute to the overall water management program. Attempts have been made to inform landowners of the assistance available from USDA service agencies so they may select the combination of action programs to best meet their needs and desires.

A field review of all watersheds in the Basin indicated that 36 had significant problems needing project action. These watersheds were divided into two categories--early-action projects and long-range projects. Sixteen early-action projects formulated to meet immediate needs are economically feasible under present criteria, and development of these projects can start in the next 10 to 15 years. Twenty long-range projects were identified that were not justified or needed in the early-action program but have needs that may require project action during the next 50 years. Designation and location of these projects are shown on Map 17. The watersheds are not identical to those identified in the Missouri River Basin Type I Report, as they are based on a more intensive study.

A. Land Treatment and Land Use Measures

Land treatment measures can be installed with technical assistance provided through local Soil and Water Conservation Districts. These Districts, established under State law as political units, support and encourage erosion control through proper land use, terracing, contour farming, stripcropping, cropping system revision, grass waterways, and residue management. Nine additional Districts, covering 21 percent of the Basin, need to be organized in order that this service may be provided Basinwide. The Soil Conservation Service provides technical assistance to plan and apply land treatment measures through Soil and Water Conservation Districts.

Assistance in forest management is available through the Cooperative Forest Management Program provided through an agreement between the Missouri Department of Conservation and the United States Forest Service.

Assistance is available to landowners from several existing programs administered by State and Federal agencies. Information relating to land treatments and land use is available through the Extension Program of the

University of Missouri. The Agricultural Stabilization and Conservation Service cost-shares in applying some land treatment measures. Credit to apply conservation measures is available through the Farmers Home Administration.

The full resource development and utilization of the Basin would require the application of 4,706,880 acres of treatment measures on 1,677,700 acres of forest land needing treatment.

Management plans involving 511,200 acres will be written. Grazing control will be obtained on approximately 590,450 acres. This includes 320,450 acres protected by the installation of new fences and 270,000 acres presently fenced but used for grazing. Protection of this area will result from management decisions reflected in the management plans. Roughly 373,700 acres of forest land will receive hydrologic stand improvement treatment. All the area having severe erosion problems, approximately 93,680 acres, will be treated.

Forest land receiving all needed treatments totals 467,380 acres. Together with the 561,200 forest acres now adequately treated, a total of 1,028,580 forest acres (46 percent) will be adequately treated by year 2000. The remaining 1,210,320 acres of forest land will receive partial or no treatment.

A summary of Basin needs and estimated accomplishments under the present rate of application and the additional accomplishment in the early-action projects with an accelerated program is shown in Table 53. Table 54 includes a further breakdown of forest land needs and treatment above proposed and existing structures other than P. L. 566 and below all structures. Costs of land treatment are shown on Table 55.

Individual landowners should consider conversion to permanent meadow, woodland or wildlife areas, land that is too steep or too eroded to be left in cropland. Diversions, surface field ditches, land smoothing and grading, and cultural practices to improve soil structure are required on lands having wetness problems.

Pasture land requires high level management practices to provide an economical return and provide proper grazing control. These practices include: liming, fertilizing, re-seeding with improved pasture mixes, brush control, rotation pasture, fencing, and additional water supplies.

Under present forestry programs, private landowners can receive financial assistance to enable them to build fences to exclude livestock from forest areas, improve timber stands, and plant problem areas to trees.

Basinwide, almost 81,700 acres of forest land are considered as critical sediment-producing areas. The elimination of grazing on steep slopes and tree planting on the poorly stocked areas will stimulate litter and humus production, thereby protecting the soil from surface runoff.

Approximately 1,915,400 acres of forest land are in the area above water control structures--existing, under construction, or planned by the Corps of Engineers; the privately owned Lake of the Ozarks, and in early-action projects. Forest land treatment on this area can be accomplished under the

Table 53. Estimated Land Treatment Accomplishments by 2000: South Grand-Osage River Basin, Missouri

Conservation Treatment Practices	Early-Action P.L. 566 Projects and Complementary Programs			Early-Action Programs Not Associated With P.L. 566 Projects			Total Basin			
	Present Needs	Going Program	Accel-erated Program	Present Needs	Going Program	Accel-erated Program	Present Needs	Going Program	Going and Accelerated Programs	Remaining Needs 1/
					(Acres)					
Cropland:										
Annual cover	44,960	11,690	22,480	67,240	16,750		112,200	28,440	50,920	52,640
Rotation meadow	58,250	15,150	29,130	79,950	20,850		138,200	36,000	65,130	62,310
Contour farming	9,620	1,250	1,920	5,680	810		15,300	2,060	3,980	10,090
Terraces, diversions, stripcropping	395,910	51,470	79,180	593,290	77,200		989,200	128,670	207,850	704,560
Permanent cover	34,390	4,470	10,320	63,610	8,390		98,000	12,860	23,180	67,200
Drainage needed	41,240	5,360	12,370	49,860	6,620		91,100	11,980	24,350	59,690
Subtotal	584,370	89,390	155,400	859,630	130,620		1,444,000	220,010	375,410	956,490
Adequately treated	253,890			586,410			840,300			
Total Cropland	838,260			1,446,040			2,284,300			
Pasture:										
Protect from overgrazing	52,060	13,540	10,410	99,140	25,870		151,200	39,410	49,820	92,360
Improvement of cover	108,230	14,070	21,650	151,970	19,270		260,200	33,340	54,990	189,670
Brush control	20,710	2,690	4,140	65,990	8,660		86,700	11,350	15,490	66,010
Reestablishment of cover	101,950	13,250	20,390	304,150	39,150		406,100	52,400	72,790	308,970
Brush control and reestablishment	79,680	10,360	15,940	241,520	31,670		321,200	42,030	57,970	244,030
Subtotal	362,630	53,910	72,530	862,770	124,620		1,225,400	178,530	251,060	901,040
Adequately treated	90,620			179,080			269,700			
Total Pasture	453,250			1,041,850			1,495,100			
Forest:										
Management plans	320,000	10,000	89,200	1,357,700	84,000	328,000	1,677,700	94,000	511,200	1,166,500
Grazing control	320,000	500	86,550	700,200	62,300	171,100	1,020,200	62,800	320,450	699,750
Severe erosion area	2,000		2,000	67,500	20,000	47,500	69,500	20,000	69,500	
Planting - open	43,000	300	26,500	57,000	2,200	14,300	100,000	2,500	43,300	56,700
Planting - forest	96,000	20	2,500	379,800	16,700	94,900	475,800	16,720	114,120	361,680
Severe erosion area	400		400	11,800	5,300	6,500	12,200	5,300	12,200	
Hydrologic stand improvement	291,860	3,400	50,500	1,047,640	57,900	261,900	1,339,500	61,300	373,700	965,800
Erosion control										
Log roads & skid trails	1,000		1,000	10,980	3,250	7,730	11,980	3,250	11,980	
Total cumulative needs	1,074,260			3,632,620			4,706,880			3,250,430
Total measures		14,220	258,650		251,650	931,930		265,870	1,456,450	
Treatment area	320,000	3,400	53,900	1,357,700	86,450	323,630	1,677,700	89,850	467,380	1,210,320
Adequately treated	99,500			461,700			561,200			
Total Forest 2/	419,500			1,819,400			2,238,900			

1/ Remaining needs were adjusted to reflect the estimated increase in non-inventory acres by year 2000.
2/ Total Forest acres does not include 86,300 acres of non-commercial forest lands (parks, etc.). Total Forest Land equals 2,325,200 acres.

Cooperative Forest Management Program offered by the State Conservation Commission and the United States Forest Service. The opportunities for forest land treatment under this program are presented in Tables 53 and 54. The remaining Basin forest land, 323,500 acres, is situated below structures (Table 54). This area is mainly below Bagnell Dam along the lower Osage River and includes Tavern Creek and the lower extremities of the Maries Watershed. Forest land treatment needs in this area can be met if existing programs are funded at the authorized level.

Table 54. Distribution of Forest Land Needs and Treatments in Areas Other Than P.L. 566 Watersheds: South Grand-Osage River Basin, Missouri

Conservation Treatment Practices	Early-Action Projects Above Structures Other Than P.L. 566			Remaining Basin Below P.L.566, C of E, or Other Structures	
	Present Needs	Going Program	Accel-erated Program	Present Needs	Going Program
			(Acres)		
Management plans	1,176,550	69,900	328,000	181,150	14,100
Grazing control	659,800	57,300	171,100	40,400	5,000
Severe erosion area	47,500		47,500	20,000	20,000
Planting - open	55,000	1,000	14,300	2,000	1,200
Planting - forest	373,800	15,000	94,900	6,000	1,700
Severe erosion area	8,000	1,500	6,500	3,800	3,800
Hydrologic stand improvement	1,011,440	57,300	261,900	36,200	600
Erosion control					
Log roads & skid trails	8,230	500	7,730	2,750	2,750
Total cumulative needs	3,340,320			292,300	
Total measures		202,500	931,930		49,150
Treatment area	1,176,550	59,300	323,630	181,150	27,150
Adequately treated	319,350			142,350	
Total Forest	1,495,900			323,500	

Table 55. Estimated Cost of Land Treatment Accomplishments by Year 2000: South Grand-Osage River Basin, Missouri

Land Use	Installation Cost			Technical Assistance		
	Going	Accelerated	Total	Going	Accelerated	Total
			(Dollars in Thousands)			
Cropland	6,324.6	4,206.3	10,530.9	1,264.9	841.3	2,106.2
Pasture	4,692.1	3,407.6	8,099.7	469.2	340.8	810.0
Forest	3,900.6	17,467.0	21,367.6	1,336.2	13,362.6	14,698.8
TOTAL	14,917.3	25,080.9	39,998.2	3,070.3	14,544.7	17,615.0

B. Water Supply and Water Quality

The Farmers Home Administration can assist communities of 5,500 or less in obtaining water and sewage systems. To be eligible, the community must be located in an area for which a regional water and sewer plan has been developed. In general, water supply and distribution systems are feasible with FHA assistance when population concentrations can provide four or more service connections per mile of service main. Assistance from the Farmers Home Administration is in the form of grants and loans for planning and construction, and through purchase of revenue bonds that cannot be sold on the open market. Many rural Water Supply Districts and cities within the Basin have taken advantage of this program. While sewer systems and sewage treatment plants are eligible for assistance under the Farmers Home Administration Program they have benefited by a much lesser degree because other sources of Federal assistance are available for these purposes.

C. Fish and Wildlife

Wildlife habitat and fishing opportunities can be improved by considering these functions in planning land use on farms and by proper land treatment measures aimed at wildlife habitat improvement. The Soil and Water Conservation District programs provide opportunity to create wildlife cover and food-plot areas. Additional emphasis can be placed on informational programs to improve landowner-hunter relations. Farm ponds, constructed with A.S.C.S. assistance, can contribute materially to the fisheries. Storage, available in most structures, should be considered in reservoir planning to assure minimum flows necessary for fish and wildlife purposes. Land retirement under the Feed Grain and Crop Adjustment Programs of the Agricultural Stabilization and Conservation Service have increased small game habitat. With increased funding and application, these programs would provide additional habitat for wildlife.

Wildlife resources can be improved also through forest land treatment under the Cooperative Forest Management Program offered by the Missouri Conservation Commission and United States Forest Service.

D. Rural Electrification

Nearly all the housing units within the Basin have electricity available. The electric cooperatives, assisted by the Rural Electrification Administration, have the capability to serve all but the most isolated locations. The community services provided by the cooperatives are expected to expand, and the presence of available electric power encourages industry to locate throughout the Basin. Added uses of electricity in the home and on the farm, coupled with anticipated increase in industrial use, indicates need for a fourfold increase in power supply in the immediate 10 to 15-year period. The sources of supply can be supplied partially from hydroelectric installations proposed at Stockton, Pomme de Terre, and Kaysinger Bluff Reservoirs, and from thermal power units utilizing coal reserves in the Upper Basin.

E. Recreation

Excellent opportunities to supplement the income of Basin residents are associated with providing recreation lands and facilities to serve people from urban areas. Loans from the Farmers Home Administration are available to develop income-producing recreational facilities. The Small Watershed Program under provisions of Public Law 566 offers the greatest opportunity for public recreation developments. These opportunities are detailed under Section G of this chapter.

F. Resource Conservation and Development Projects

Public Law 87-703 authorized the Secretary of Agriculture to cooperate with Federal, State, and other public agencies to assist in developing plans with the people of an area. These plans, locally initiated and sponsored, are identified as Resource Conservation and Development (RC&D) Projects. Their purpose is to help local people improve the overall economic and social conditions and to develop, utilize, and conserve the natural and human resources of the area. This can be done through coordinating and accelerating the current program, authorizing new programs, and stimulating local people to individual and group action.

All the South Grand-Osage River Basin has the potential to develop multiple community RC&D Projects. In addition to the existing Southwest RC&D Projects which include Barton, Cedar, Dade, and Lawrence Counties, the counties in the Kaysinger Regional Planning Commission appear to have the best potential in the Basin. These counties involve Vernon, Bates, Henry, St. Clair, Benton, and Hickory.

G. Potential Watershed Projects

Many of the preceding programs are complemented or incorporated in Public Law 566, Small Watershed Program. This program is designed to coordinate all USDA Conservation Programs within approved project areas and to assist communities in accomplishing more complete water management. The Small Watershed Program is applicable to drainage areas of 250,000 acres or less, and encourages community action in the functions of flood protection and prevention, soil conservation, recreation, fish and wildlife, water supply, and to a limited degree--drainage. The approach is usually through Subdistricts of the local Soil and Water Conservation District. Cost sharing of control structures and other works beyond the capability of individual landowners is provided through the Soil Conservation Service.

Opportunities for development through the Public Law 566 Program fall into two major categories--land treatment and structural measures. Additional funds are available for providing technical assistance for installing soil and water conservation land treatment measures on individually owned property. Cost-sharing for installing these measures may be made available in some cases, if justified, as a necessary incentive to meet the project objectives. Funds for technical assistance and grants are available also for installing structural measures to supplement the land treatment program. Opportunities under these phases of Public Law 566 are discussed in the next two sections for potential projects in the early-action program.

Before project: Erosion, sediment, and flooding are products of unprotected watersheds.

After project: Both land treatment and structural measures make an integrated watershed management program.

1. Land Treatment

The opportunities for installing needed land treatment measures in the 16 watersheds proposed for development in the early-action projects appear very favorable. The 1966 Conservation Needs Inventory reveals that 30 percent of the cropland, 20 percent of the pasture, and 24 percent of the forest land have been adequately treated. The major remaining needs on cropland are the installation of terraces, grass waterways, stripcropping, and diversions. Improvement and reestablishment of cover and brush control are the most significant treatment needs on pasture. See Table 53 for the total needs and estimated measures for land treatment that could be installed during the project period under the present criteria.

To meet land treatment provisions of Public Law 566 for lands above proposed structures, basic conservation plans will be required on 405,000 acres including 82,000 acres of forest. Technical assistance in planning and supervision of installation is available to the landowner.

The protection of water quality in the reservoirs proposed for recreation and municipal and industrial water supply would be significantly increased by the establishment of good grass or tree cover on land adjacent to the water. This includes approximately 24,800 acres of land. About 7,600 acres are needed for basic facilities; approximately 3,500 acres of existing forest land and 13,700 acres of open land would require establishment of cover or intensive management for improved watershed protection.

2. Structural Measures

The early-action projects have a drainage area of 3,179 square miles. Within these projects, there is an opportunity to reduce floodwater damages and improve drainage on 117,910 acres of bottomland with 98 proposed structures and 69.5 miles of channel improvement. Of the proposed structures, 64 are single purpose flood prevention; 8 have storage for municipal and industrial water supply and flood prevention; 18 have storage for recreation and flood prevention; and 8 have flood prevention, recreation, and municipal and industrial storage. The distribution of structures by watersheds and the physical potential of these structures are found in Tables 56 and 57.

The estimated floodwater damages amounts to $1,905,360 of which 81 percent stems from crops and pasture. The proposed structures will control a drainage area of 1,265 square miles, or approximately 40 percent of the drainage area in the projects. This control is expected to reduce damage to $768,110 resulting in a benefit of $1,137,250 (Table 58).

The early-action projects include 16 structures with storage for municipal and industrial use. A total of 31,847 acre-feet of storage is included in these structures. This storage will provide a water supply for 22 towns which will be adequate to meet present and projected requirements to the year 2020.

The early-action projects also include 26 structures with storage for recreation and/or fish and wildlife. These structures would have a total surface area of 9,318 acres, and an additional land area of 23,950 acres is

Table 56. Upstream Watershed Projects Recommended in the 10 to 15-Year Period: South Grand-Osage River Basin, Missouri

Project	Area (Sq.Mi.)	Structures				Channel Improvement (Mile)
		Flood Prevention Only (No.)	Flood Prev. and Municipal & Industrial (No.)	Flood Prevention and Recreation (No.)	Flood Prev. Municipal & Industrial Recreation (No.)	
Upper Big Creek	248.3	8	2	3	2	26.3
Lower Big Creek	285.2	5	1	3	1	22.5
Upper South Grand River	389.2	4	1	5	2	
Middle South Grand River	332.3	8	1	5	1	11.6
Fields Creek	21.7	1				
Miami Creek	208.7	4		1	1	3.6
Deepwater Creek	108.2	5				
Panther Creek	59.1	1	1			
Monegaw Creek	80.8	2				
Drywood Creek	346.2	4				
Little Drywood Creek 1/	175.9	6			1	5.5
Cedar-Horse Creek 1/	367.9	10				
Alder Creek	61.5		1			
Brush Creek	84.8	1				
Bear Creek	118.5	2	1			
Maries River	291.1	3		1		
TOTAL	3,179.4	64	8	18	8	69.5

1/ Watershed applications are approved.

Table 57. Structure Data - Floodwater Retarding Structures: South Grand-Osage River Basin, Missouri

Watershed Number	Structural Measures and Purposes	Drainage Area Controlled (Sq.Mi.)	Surface Area Pool (Ac.)	Sediment 100 yr. (A.F.)	Flood Prev. (A.F.)	M & I (A.F.)	Recreation (A.F.)	Total Storage (A.F.)	Remaining Storage Available (A.F.)
1	8F, 2FM, 3FR, 2FMR	117.12	2,374	5,670	29,754	4,741	14,853	55,018	30,100
2	5F, 3FR, 1FMR, 1FM	90.98	1,281	4,466	24,529	544	4,268	33,807	14,300
3	4F, 1FM, 5FR, 2FMR	139.31	2,549	6,512	32,041	11,561	20,104	70,218	9,400
4	8F, 1FM, 5FR, 1FMR	125.46	2,740	6,183	31,635	1,792	21,368	60,978	7,160
5	1F	6.54	57	345	1,970			2,315	1,000
6	4F, 1FR, 1FMR	113.84	1,176	4,845	31,577	2,380	4,135	42,937	30,315
7	5F	60.65	348	2,830	15,833			18,663	11,100
8	1F, 1FM	36.41	368	1,576	9,327	1,058		11,961	14,300
9	2F	23.19	135	1,110	6,348			7,458	7,200
10	4F	100.79	417	4,059	25,091			29,150	17,000
11	6F, 1FMR	83.11	798	3,547	22,124	5,620	712	32,003	15,439
12	10F	164.90	539	4,893	47,381			52,274	36,000
13	1FM	18.08	350	540	5,014	2,460		8,014	10,000
14	1F	30.09	60	514	5,776			6,290	4,100
15	2F, 1FM	49.96	314	972	11,315	1,691		13,978	7,800
16	3F, 1FR	104.82	542	1,859	20,367		5,099	27,325	9,990
TOTAL		1,265.25	14,048	49,921	320,082	31,847	70,539	472,389	225,204

F - Floodwater Retarding
FM - Floodwater & M & I
FR - Floodwater & Recreation
FMR - Floodwater, M&I, & Recreation

Table 58. Summary of Damage and Damage Reduction Benefits for 10 to 15-Year Projects: South Grand-Osage River Basin, Missouri

(Dollars) 1/

Watershed Number	Watershed	Flood Plain Acres	Present Damage 2/					Remaining Damage 2/					Damage Reduction Benefits
			Crop and Pasture 1/	Other Agricultural	Non-Agricultural	Indirect	Total Damage	Crop and Pasture	Other Agricultural	Non-Agricultural	Indirect	Total Damage	
1	Upper Big Creek	12,570	217,970	10,840	24,880	25,370	279,060	62,280	2,870	3,700	6,880	75,730	203,330
2	Lower Big Creek	18,700	201,720	10,840	16,160	22,860	251,580	96,620	4,740	9,450	11,080	121,890	129,690
3	Upper South Grand River	17,050	252,400	12,930	13,380	27,870	306,580	75,700	3,580	3,690	8,300	91,270	215,310 3/
4	Middle South Grand River	21,160	317,160	16,010	8,260	34,140	375,570	139,400	6,440	3,080	14,890	163,810	211,760 3/
5	Fields Creek	1,180	12,810	930	1,280	1,500	16,520	8,490	590	850	990	10,920	5,600
6	Miami Creek	6,380	119,020	6,610	1,650	12,730	140,010	44,320	2,350	640	4,730	52,040	87,970
7	Deepwater Creek	3,270	38,330	2,500	2,700	4,350	47,880	16,100	990	1,400	1,850	20,340	27,540
8	Panther Creek	2,350	9,560	1,150	1,500	1,220	13,430	2,440	260	310	300	3,310	10,120
9	Monegaw Creek	1,710	8,210	820	1,030	1,000	11,060	4,660	420	530	560	6,170	4,890
10	Drywood Creek	8,540	98,370	12,740	5,240	11,630	127,980	56,000	6,980	2,070	6,500	71,550	56,430 4/
11	Little Drywood Creek	5,330	88,920	11,300	2,080	10,230	112,530	27,550	4,100	670	3,230	35,550	76,980
12	Cedar-Horse Creek	7,580	49,650	3,800	2,970	5,640	62,060	16,590	1,140	810	1,850	20,390	41,670
13	Alder Creek	1,400	22,070	1,710	1,160	2,500	27,440	10,940	760	560	1,230	13,490	13,950
14	Brush Creek	1,540	6,330	610	350	730	8,020	3,440	330	170	400	4,340	3,680
15	Bear Creek	2,780	21,140	1,840	1,000	2,400	26,380	11,180	920	530	1,260	13,890	12,490
16	Maries River	6,370	81,560	4,930	3,750	9,020	99,260	52,520	3,120	2,020	5,760	63,420	35,840
TOTAL		117,910	1,545,220	99,560	87,390	173,190	1,905,360	628,230	39,590	30,480	69,810	768,110	1,137,250

1/ Price Base: Adjusted normalized prices.
2/ Damages reflect changes in land use and technology.
3/ Includes damage reduction benefits to proposed C of E Freeman Reservoir.
4/ Includes damage reduction benefits allocated to Kansas.

Table 59. Comparison of Benefits and Costs for Structural Measures (10 to 15-Year Projects): South Grand-Osage River Basin, Missouri

(Dollars)

Watershed Number	Watershed	Average Annual Benefits 1/									Annual Costs 2/	B:C Ratio
		Damage Reduction	More Intensive Land Use	Changed Land Use	Drainage	Recreation	Water Supply	Redevelopment	Secondary	Total Benefits		
1	Upper Big Creek 3/	213,860	47,480	44,800	14,370	1,281,720	11,000		203,190	1,816,420	793,360	2.3:1.0
2	Lower Big Creek	119,160	36,350	32,980	13,800	313,540	2,730		76,290	594,850	422,080	1.4:1.0
3	Upper South Grand River 3/	191,240 4/	71,130	38,260		1,229,920	27,310		197,480	1,755,340	654,570	2.7:1.0
4	Middle South Grand River	126,020 4/	40,250	32,790	7,500	274,280	5,890		94,650	581,380	543,270	1.1:1.0
5	Fields Creek	5,600	2,360	4,660					2,640	15,260	6,560	2.3:1.0
6	Miami Creek	87,970	24,850	21,150	6,280	94,210	3,810		36,460	274,730	213,050	1.3:1.0
7	Deepwater Creek	27,540	14,440	14,670					10,430	67,080	59,160	1.1:1.0
8	Panther Creek	10,120	2,530	15,190			2,460		6,170	36,470	36,490	1.0:1.0
9	Monegaw Creek	4,890	2,280	10,760				1,150	4,380	23,460	19,050	1.2:1.0
10	Drywood Creek	31,730 5/	9,820	24,410				3,900	12,200	82,060	75,770	1.1:1.0
11	Little Drywood Creek	76,980	14,650	26,390	4,950	43,080	9,310	2,300	29,920	207,580	146,620	1.4:1.0
12	Cedar-Horse Creek 3/	49,570	45,300	21,220				6,710	19,440	142,240	103,480	1.4:1.0
13	Alder Creek	6,050	4,890	1,740			5,500	970	2,470	21,620	18,540	1.2:1.0
14	Brush Creek	3,680	5,290	4,940				990	2,730	17,630	15,880	1.1:1.0
15	Bear Creek	12,490	16,080	4,620			3,570	2,520	5,950	45,230	40,310	1.1:1.0
16	Maries River	35,840	7,910	5,380		121,260		3,120	22,800	196,310	129,230	1.5:1.0
TOTAL		1,002,740	345,610	303,960	46,900	3,358,010	71,580	21,660	727,200	5,877,660	3,277,420	1.8:1.0

1/ Price Base: Adjusted normalized prices.
2/ 1967 Construction costs amortized 100 years @ 4 7/8 percent interest.
3/ Includes benefits from downstream watersheds.
4/ Does not include damage reduction benefit allocated to proposed C of E Freeman Reservoir.
5/ Does not include damage reduction benefit allocated to Kansas.

included in the cost estimates for temporary flood storage and basic recreational facilities. These public recreational areas would be operated and maintained by a non-federal entity.

In addition to the storages shown for the above purposes, the full potential development of all sites would include 225,204 acre-feet of additional storage. Local sponsors could decide to include this storage for eligible purposes such as: irrigation, augmentation of low stream flows to benefit fish and wildlife, municipal and industrial water supply, and recreation.

The total first cost of the 16 watersheds recommended for development in the early-action projects is estimated at $49,852,160 (Table 61). The total annual cost including operation and maintenance would be $3,277,420, and the total annual benefits would be $5,877,660 (Table 60). This results in a benefit-cost ratio of 1.8 to 1.0. Excluding secondary benefits of $727,200 (Table 59), the benefit-cost ratio is 1.5 to 1.0. Average annual costs and benefits were based on 4 7/8 percent interest and amortized for 100 years.

The United States Department of Agriculture's share of the costs under P.L. 566 is $25,987,850 or 52 percent, and the non-federal share is $23,864,310 or 48 percent. This non-federal share includes the following items:

1. Cost of easements; cost of land rights, including relocations of public utilities for single purpose floodwater retarding structures.

2. Fifty percent of the land rights, and construction cost allocation to recreation and/or fish and wildlife.

3. All cost allocated to municipal and industrial water storage.

4. Minor cost allocated to administration of contracts, legal fees, etc.

The operation and maintenance of all structural improvements also would be a non-federal responsibility.

The Corps of Engineers have investigated four structure sites for water supply, recreation, and flood control purposes--Nevada Reservoir, Butler Reservoir, Freeman Reservoir, and East Branch Reservoir. These structures are in three watersheds included in early-action projects--Little Drywood Creek, Miami Creek, and Upper South Grand River Watersheds. The proposed USDA projects are considered first alternates for the East Branch, Nevada, and Butler Reservoirs. The Corps of Engineers' Freeman Reservoir was considered first alternate for three USDA structure sites in Upper South Grand River Watershed. Freeman Reservoir is planned to supplement the water supply for Kansas City.

Following is a summary statement on each watershed project proposed for early-action development. Concurrent development should be made on Upper and Middle South Grand River Watersheds; Upper and Lower Big Creek Watershed; and Cedar-Horse and Alder Creek Watersheds.

Table 60. Estimated Costs and Benefits for 10 to 15-Year Plan: South Grand-Osage River Basin Missouri

(Dollars) 1/

Watershed Number	Structural Measures and Purposes 2/	Annual Cost: Amortization of Installation Costs 3/	Annual Cost: Operation and Maintenance Costs	Annual Cost: Total Annual Costs 4/	Annual Benefits	Benefit Cost Ratio
1	8F, 2FM,3FR,2FMR,26.3CI	514,130	224,320	793,360	1,816,420	2.3:1.0
2	5F,1FM, 3FR,1FMR,22.5CI 5/	280,830	102,950	422,080	594,850	1.4:1.0
3	4F, 1FM,5FR,2FMR	428,670	179,800	654,570	1,755,340	2.7:1.0
4	8F, 1FM,5FR,1FMR,11.6CI 5/	375,040	111,340	543,270	581,380	1.1:1.0
5	1F	5,700	230	6,560	15,260	2.3:1.0
6	4F, 1FR,1FMR, 3.6CI 5/	146,740	46,470	213,050	274,730	1.3:1.0
7	5F	51,170	1,830	59,160	67,080	1.1:1.0
8	1F, 1FM	31,820	980	36,490	36,470	1.0:1.0
9	2F	16,510	620	19,050	23,460	1.2:1.0
10	4F	66,820	1,830	75,770	82,060	1.1:1.0
11	6F, 1FMR, 5.5CI	99,920	33,310	146,620	207,580	1.4:1.0
12	10F,	88,750	3,470	103,480	142,230	1.4:1.0
13	1FM	16,440	460	18,540	21,630	1.2:1.0
14	1F	13,780	380	15,880	17,630	1.1:1.0
15	2F, 1FM	34,820	1,230	40,310	45,230	1.9:1.0
16	3F, 1FR	79,750	37,850	129,230	196,310	1.5:1.0
TOTAL	64F,8FM,18FR,8FMR,69.5CI 5/	2,250,890	747,070	3,277,420	5,877,660	1.8:1.0

1/ Price Base 1967
2/ F-Flood Retarding; M-Municipal & Industrial Water; R-Recreation; 3.6CI-3.6 Mi.Channel Imp.
3/ 100 Years - 4 7/8 Percent Interest
4/ Includes Project Administration
5/ Includes Present Value of Basic Recreation Facilities to be built in year 2000.

Table 61. Cost Allocation by Purpose: South Grand-Osage River Basin, Missouri

(Dollars) 1/

Watershed Number	Total Structural Measures	Single Purpose Flood Prev.	Multiple Purpose: Flood Prevention	Municipal & Industrial	Recreation	Drainage	Total
1	10,456,100	1,131,900	3,033,800	218,300	5,901,600	170,500	9,324,200
2	6,454,100	822,300	2,625,600	54,000	2,801,000 2/	151,200	5,631,800
3	9,421,600	547,300	1,144,500	544,200	7,185,600		8,874,300
4	9,795,200	1,134,200	2,659,800	115,500	5,715,300 2/	170,400	8,661,000
5	116,000	116,000					
6	3,445,200	948,400	664,500	75,900	1,728,900 2/	27,500	2,496,800
7	1,040,700	1,040,700					
8	647,100	296,500	301,700	48,900			350,600
9	335,900	335,900					
10	1,359,000	1,359,000					
11	2,032,350	891,000	498,050	183,700	432,100	27,500	1,141,350
12	1,804,710	1,804,710					
13	334,400		225,400	109,000			334,400
14	280,200	280,200					
15	708,000	380,100	257,200	70,700			327,900
16	1,621,600	709,000	121,600		791,000		912,600
TOTAL	49,852,160	11,797,210	11,532,150	1,420,200	24,555,500	547,100	38,054,950

1/ Price Base 1967
2/ Includes Special Recreation Cost.

Upper Big Creek Watershed (1)

Upper Big Creek Watershed is located in the northwestern area of the Basin; Big Creek is a northern tributary to the South Grand River. The drainage area of 248 square miles is located in Cass, Johnson, and Jackson Counties. Cass and Johnson Counties have Soil and Water Conservation Districts.

Four towns are having municipal water shortages, and the entire watershed is within the 50-mile radius of Kansas City which is in need of water-based recreation areas. About 12,570 acres of flood plain are in the watershed. (Table 58) Part of the town of Pleasant Hill is subject to flooding. A railroad follows much of the flood plain preventing the location of floodwater detention structures. The upper portion is in the area of urbanization pushing out from Kansas City. Lake Winnebago, a new development built around a 252-acre lake, is located in the watershed.

About 47 percent of the drainage area or 117 square miles would be controlled by eight single purpose flood detention structures and seven multipurpose structures. A volume of 4,741 acre-feet of water would be stored in four structures for municipal and industrial use by four towns. In five structures, 1,908 acres of surface water would be available for water-based recreation and/or fish and wildlife. An adjoining 4,714 acres of land would be available to supplement the water recreation area. An additional 30,100 acre-feet of water is available and could be used for other purposes. Through Pleasant Hill and in the lower area of the watershed, about 26 miles of channel improvement is needed to reduce the floodwater damage and also facilitate better drainage. Both channel improvement and structures are needed to control flooding around Pleasant Hill.

The total first installation cost would be $10,456,100 (Table 61). The annual cost, including operation and maintenance, would be $793,360 and the annual benefits $1,816,420 (Table 60).

Lower Big Creek Watershed (2)

Lower Big Creek Watershed has a drainage area of 285 square miles. It is located in the northwestern part of the Basin south of Kansas City in Cass County, Johnson County, and Henry County Soil and Water Conservation Districts.

Three towns are having problems of securing sufficient water for their population and need additional water for expansion. In addition, most of the watershed is within 50 miles of Kansas City which is in need of water-based recreation areas. Within the watershed, 18,700 acres are in the flood plain (Table 58). About 9,100 acres are in the Kaysinger Bluff Reservoir flood pool above the five-year frequency.

An area of 91 square miles or about 32 percent of the drainage area would be controlled by five single purpose flood detention structures and five multi-purpose structures. A volume of about 544 acre-feet of water would be stored for municipal and industrial use in two structures for three towns in the area. In four structures, an area of 987 acres of surface water would be available for water-based recreation and/or fish and wildlife. An adjoining 2,928 acres would be available to supplement the water recreation

area. These structures can supply an additional storage of 14,300 acre-feet which is available for purposes not specified in this plan. In the lower area of the watershed, about 23 miles of channel and levee improvement would be needed for flood control and incidental drainage.

The total first cost of installation would be $6,454,100 (Table 61). The annual cost, including operation and maintenance, would be $422,080 and benefits would be $594,850 (Table 60).

Upper South Grand River Watershed (3)

Upper South Grand River Watershed has 389 square miles of drainage area. It is located in the northwestern corner adjoining Kansas City. The drainage area is included in Cass County and Bates County Soil and Water Conservation Districts. Its headwaters is in Kansas. Individuals in the Grand River Drainage District have indicated interest in alleviating the flooding problem.

Four towns are having problems of securing sufficient water for their population and are in need of additional water for expansion. In addition, all the area within 50 miles of Kansas City is in need of water-based recreation areas. Within the watershed, 17,050 acres are in the flood plain (Table 58).

The Corps of Engineers made preliminary plans for a structure in the upper reaches near Freeman controlling 90 square miles or 23 percent of the Upper South Grand drainage area. In addition to this, about 36 percent or 139 square miles would be controlled by proposed USDA structures. The combined Corps of Engineers and USDA proposals would control 59 percent or 229 square miles. The USDA projects propose control with four single purpose flood prevention structures and eight multi-purpose structures. Seven of these multi-purpose structures include recreation and/or fish and wildlife with a total of 2,353 surface acres of water and an adjoining land area of about 6,310 acres. Three of the structures would have 11,561 acre-feet of storage allocated to municipal and industrial use by four towns in the area. Five structures have additional storage of 9,400 acre-feet that can be developed for other uses.

The total first cost of installation would be approximately $9,421,600 (Table 61). The annual cost, including operation and maintenance, would be $654,570 and the benefits would be $1,755,340 (Table 60).

Middle South Grand River Watershed (4)

Middle South Grand River Watershed has a drainage area of 332 square miles. It is located in the northwestern area downstream from Upper South Grand River Watershed. The drainage area is included in Cass County, Bates County, and Henry County Soil and Water Conservation Districts. Individuals in the Grand River Drainage District have shown some interest in this project.

Five towns are having municipal water shortages. The upper half of the watershed which is within 50 miles of Kansas City is in need of water-based recreation areas. Within this watershed, the flood plain area is 21,160 acres

(Table 58). Approximately 11,500 acres are in the flood pool above the five-year frequency of Kaysinger Bluff Reservoir.

An area of 125 square miles or 38 percent of the drainage area would be controlled by eight single purpose flood detention structures and seven multi-purpose structures. A volume of 1,792 acre-feet of water would be stored in two of the structures for municipal and industrial use by five towns. In six of the structures, 2,353 acres of surface water would be available for water-based recreation and/or fish and wildlife. An adjoining land area of 6,348 acres would be available to supplement the water recreation area. In seven structures, an additional 7,160 acre-feet of water would be stored for beneficial use. The lower main stem reaches would need about 12 miles of channel improvement for flood control and drainage.

The total first cost of installation would be approximately $9,795,200 (Table 61). The annual cost, including operation and maintenance, would be $543,270 and the annual benefits would be $581,380 (Table 60).

Fields Creek Watershed (5)

Fields Creek Watershed comprises a drainage area of 22 square miles. It is located in the Henry County Soil and Water Conservation District, entering the South Grand River from the north near Clinton, Missouri.

Bottomland subject to flooding is 1,180 acres (Table 58). The lower 750 acres is in the Kaysinger Bluff flood pool above the five-year frequency. Opportunity exists for one single purpose flood detention structure which would control about seven square miles or approximately 30 percent of the total area. This would have an initial installation cost of about $116,000 (Table 61). The average annual cost would be $6,560 and annual benefits would be $15,260 (Table 60).

Miami Creek Watershed (6)

Miami Creek Watershed is located in the western portion of the Basin. It has a drainage area of 209 square miles which lies mostly in the Bates County Soil and Water Conservation District. The headwaters of the watershed is in Kansas. The watershed drains into the Osage River as a north tributary, south of Butler. The Corps of Engineers have studied a site for municipal and industrial water for Butler in this watershed.

About 6,380 acres are subject to flooding (Table 58); and in the lower four miles, channel improvement for flood prevention is needed. This watershed is in the 50-mile radius of Kansas City which has need for water-based recreation. Butler, with a proposed future population in the year 2020 of 10,197, will be in need of municipal and industrial water storage as well as a water-based recreational area.

Approximately 114 square miles or 55 percent of the total area would be controlled by a combination of four single purpose flood detention structures and two multi-purpose structures. One of these would have 2,380 acre-feet of water stored for municipal and industrial use. Both multiple purpose

structures would have a total of 822 acres of surface water and 2,426 acres of adjoining land that could be used for recreational development and/or fish and wildlife. These structures have an additional available storage of 30,315 acre-feet. The lower area of the watershed also would need about four miles of channel improvement for flood control and drainage.

The initial installation cost would be $3,445,200 (Table 61). The annual cost, including operation and maintenance, would be $213,050 and annual benefits would be $274,730 (Table 60).

Deepwater Creek Watershed (7)

Deepwater Creek Watershed has a total drainage area of 108 square miles above Montrose Lake. It drains parts of Bates and Henry Counties and is a south tributary to the South Grand River. Montrose Lake was built by the Kansas City Power and Light Company, and water is used for cooling by the electric generation units.

An area of 3,270 acres of flood plain is located above Montrose Lake and is subject to flooding (Table 58).

Five single purpose flood detention structure sites are feasible at an installation cost of $1,040,700 (Table 61). They would control about 61 square miles or 56 percent of the area. Additional available storage is 11,000 acre-feet. The average annual cost, including operation and maintenance, would be $59,160 and annual benefits would be $67,080 (Table 60).

Panther Creek Watershed (8)

Panther Creek Watershed is located in the western area of the Basin draining 59 square miles from Bates, St. Clair, and Henry County Soil and Water Conservation Districts. It is a north tributary to the Osage River draining into the headwaters of Kaysinger Bluff Reservoir.

The flood plain consists of 2,350 acres, most of which is in the flood pool of Kaysinger Bluff Reservoir (Table 58). In the upland, a site is available that would provide future municipal and industrial water for Appleton City.

About 36 square miles or 61 percent of the drainage area would be controlled with one single purpose flood detention structure and one multipurpose municipal and industrial water supply and flood detention structure. The municipal and industrial water supply of 1,058 acre-feet would provide storage for anticipated needs to the year 2020. In addition, the structures have a potential storage of 14,300 acre-feet that could be developed.

The first installation cost would be $647,100 (Table 61). The annual cost, including operation and maintenance, would be $36,490 and annual benefits would be $36,470 (Table 60).

Monegaw Creek Watershed (9)

Monegaw Creek Watershed, located in the western area of the Basin, drains 81 square miles from St. Clair and Henry Counties. It is one of the north tributaries of the Osage River, draining into the headwaters of Kaysinger Bluff Reservoir.

Above the five-year flood pool of the Kaysinger Bluff Reservoir, a flood plain area of 1,710 acres is subject to flooding in this watershed (Table 58). Most of this flood plain is in the flood pool area.

Two single purpose flood detention structures would control approximately 23 square miles or about 29 percent of the watershed. An additional available storage of 7,200 acre-feet can be developed in these structures.

The initial installation cost of this project would be $335,900 (Table 61). The annual cost, including operation and maintenance, would be $19,050, and annual benefits would be $23,460 (Table 60).

Drywood Creek Watershed (10)

Drywood Creek Watershed has a total drainage area of 346 square miles and is located in the southwestern corner of the Basin. Part of its drainage area is in Kansas. The remainder is located in Barton County and Vernon County Soil and Water Conservation Districts. It drains into the Marmaton River upstream from Nevada.

In the Missouri portion, a flood plain area of 8,540 acres is subject to flooding (Table 58). Control of the drainage area in Kansas is needed to provide the maximum protection.

The works of improvement that could be installed in Missouri would control about 29 percent of the total watershed or about 101 square miles of drainage area. This would be in four single purpose flood detention structures. Additional storage of 17,000 acre-feet is available in these structures.

The first cost of installation would be $1,359,000 (Table 61). Including operation and maintenance, the annual cost would be $75,770 and annual benefits would be $82,060 (Table 60).

Little Drywood Creek Watershed (11)

Little Drywood Creek Watershed is located in the southwestern area of the Basin. The 176 square miles of drainage area is located in Barton County and Vernon County Soil and Water Conservation Districts. Little Drywood Creek is a south tributary to the Marmaton River near Nevada, Missouri.

A watershed application has been approved on this area, with much interest from the local people. The city of Nevada has expressed the need for a water supply and a water-based recreation area. The Corps of Engineers have investigated a site for municipal and industrial water supply, recreation, and flood prevention in this watershed.

There are 5,330 acres of flood plain below six single purpose flood detention structure sites and one multi-purpose structure site which includes storage for municipal and industrial, recreation, and flood detention. (Table 58) The multi-purpose structure would have storage of 5,620 acre-feet of water for municipal and industrial use. The lake would have a 515-acre surface area to use for water-based recreation and/or fish and wildlife plus 745 acres of adjoining land for facilities. In these structures, additicnal storage of 15,439 acre-feet could be developed. In the lower reaches of the flood plain, about 5.5 miles of channel improvement would be built to provide for flood prevention and drainage needs of the flood plain.

The total installation first cost is estimated at $2,032,350 (Table 61). Including operation and maintenance, the annual cost would be $146,620 and annual benefits would be $207,580 (Table 60).

Cedar-Horse Creek Watershed (12)

Cedar-Horse Creek Watershed has a drainage area of 367 square miles and is located in Dade County, Barton County, Cedar County, and Vernon County Soil and Water Conservation Districts. It comprises the Cedar Creek Drainage Area above the junction with Alder Creek. A watershed application has been made on this area. Alder Creek Watershed should be planned concurrently.

Approximately 7,580 acres of flood plain is subject to flooding (Table 58). Municipal and industrial water or rural water supply could be needed in the future.

An area of 45 percent of the drainage area or 165 square miles would be controlled by 10 single purpose flood detention structures. Also, these structures and the Alder Creek structure would provide flood control on the Cedar Creek reach downstream from this watershed. A total of 36,000 acre-feet of storage is available for further development in these structures.

The total first cost of installation would be $1,804,710 (Table 61). The annual cost, including operation and maintenance, would be $103,480 and annual benefits would be $142,230 (Table 60).

Alder Creek Watershed (13)

Alder Creek Watershed includes Alder Creek and the lower Cedar Creek below Alder Creek junction, all in Cedar County Soil and Water Conservation District. This watershed should be planned concurrently with Cedar-Horse Watershed. Its drainage area is 61.5 square miles. This reach of Cedar Creek outlets into the Sac River below Stockton Reservoir. Hackleman Corner Reservoir, located 4.1 channel miles above the junction of the Sac River, is an authorized Corps of Engineers' project. At present, it is in a deferred status.

A flood plain area of 1,400 acres is subject to flooding. Municipal and rural water supply is needed for future development. The multi-purpose structure would reduce flood damages on Alder Creek by controlling 47 percent of the watershed. It also contributes to the flood control on Cedar Creek.

A volume of 2,460 acre-feet of water would be available for municipal and industrial use; and an additional 10,000 acre-feet of storage is available for further development.

The first installation cost of this structure is $334,400 (Table 61). Annual cost, including operation and maintenance, would be $18,540, and annual benefits would be $21,630 (Table 60).

Brush Creek Watershed (14)

Brush Creek Watershed is located near the central part of the Basin. The drainage area is composed of parts of Polk County, Cedar County, St. Clair County, and Hickory County Soil and Water Conservation Districts. This area of 85 square miles forms an east tributary of the Sac River.

The flood plain has 1,540 acres subject to flooding (Table 58). Approximately 35 percent or 30 square miles of the watershed could be controlled with one flood detention structure. Additional storage of 4,100 acre-feet is available in the structure.

The total first cost of installation would be $280,200 (Table 61). The annual cost, including operation and maintenance, would be $15,880 and annual benefits would be $17,630 (Table 60).

Bear Creek Watershed (15)

Bear Creek Watershed comprises a drainage area of 119 square miles. The headwaters start in Polk County Soil and Water Conservation District near Bolivar. It drains into Cedar County Soil and Water Conservation District, emptying into the Sac River near Stockton below Stockton Reservoir.

An area of 2,780 acres of flood plain is subject to flooding (Table 58). Municipal and industrial water is needed also. A project of two single purpose flood detention structures and one multi-purpose structure with 1,691 acre-feet of storage for municipal and industrial use is possible. These structures would control about 42 percent of the drainage area or approximately 50 square miles. Additional storage of 4,100 acre-feet is available in these structures.

The total first cost of installation would be $708,000 (Table 61). Including operation and maintenance, the annual cost would be $40,310 and annual benefits would be $45,230 (Table 60).

Maries River Watershed (16)

Maries River Watershed enters the Osage River from the south just before the Osage enters the Missouri River. It is located south of Jefferson City and is the most eastern watershed in the Basin. The drainage area of 291 square miles includes parts of Pulaski County and Maries County Soil and Water Conservation Districts and Osage County.

About 6,370 acres are subject to flooding (Table 58). Jefferson City is close to the northern area of the watershed and could be provided needed water-based recreation.

Approximately 105 square miles or 36 percent of the drainage area would be controlled by three single purpose flood detention structures and one multi-purpose recreation and flood detention structure. This would provide a 380-acre lake with 950 acres of land adjoining that would supplement the water-based recreation and/or fish and wildlife. In addition, a storage of 9,900 acre-feet is available for development in the structure. Stream fishery would be improved if this storage were developed and used for flow augmentation.

The total first cost of this proposal would be $1,621,600 (Table 61). The average annual cost, including operation and maintenance, would be $129,230 and annual benefits would be $196,310 (Table 60).

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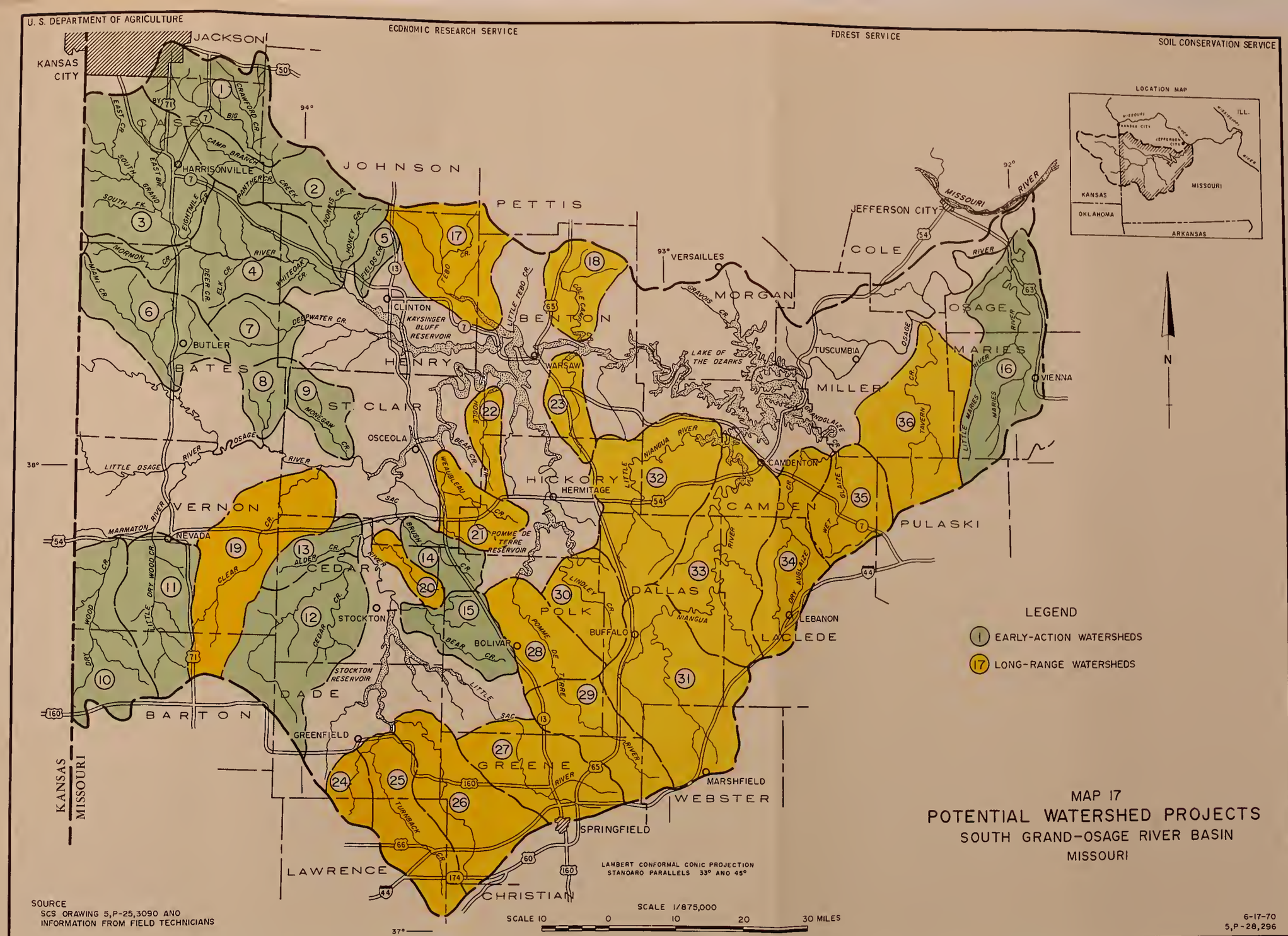
WATERSHEDS

1 UPPER BIG CREEK
2 LOWER BIG CREEK
3 UPPER SOUTH GRAND RIVER
4 MIDDLE SOUTH GRAND RIVER
5 FIELDS CREEK
6 MIAMI CREEK
7 DEEPWATER CREEK
8 PANTHER CREEK
9 MONEGAW CREEK
10 ORYWOOD CREEK
11 LITTLE ORYWOOD CREEK
12 CEDAR-HORSE CREEK
13 ALDER CREEK
14 BRUSH CREEK
15 BEAR CREEK
16 MARIES RIVER
17 TEBO CREEK
18 COLE CAMP CREEK
19 CLEAR CREEK
20 TURKEY CREEK
21 WEAUBLEAU CREEK
22 HOGLES CREEK
23 TURKEY CREEK
24 LIMESTONE CREEK
25 TURNBACK CREEK
26 UPPER SAC RIVER
27 UPPER LITTLE SAC RIVER
28 MIDDLE POMME DE TERRE RIVER
29 UPPER POMME DE TERRE RIVER
30 LINOLEY CREEK
31 UPPER NIANGUA RIVER
32 LITTLE NIANGUA RIVER
33 LOWER NIANGUA RIVER
34 DRY AUGLAIZE CREEK
35 WET AUGLAIZE CREEK
36 TAVERN CREEK



LEGEND

(1) EARLY-ACTION WATERSHEDS
(17) LONG-RANGE WATERSHEDS

MAP 17
POTENTIAL WATERSHED PROJECTS
SOUTH GRAND-OSAGE RIVER BASIN
MISSOURI

LAMBERT CONFORMAL CONIC PROJECTION
STANDARD PARALLELS 33° AND 45°

SCALE 1/875,000
SCALE 10 0 10 20 30 MILES

SOURCE
SCS DRAWING 5,P-25,3090 AND
INFORMATION FROM FIELD TECHNICIANS

6-17-70
5,P-28,296

IX. IMPACTS OF THE PROPOSED USDA PROGRAMS

By the year 2000 approximately 299,300 acres of crop, pasture, and forest land are expected to be preempted by reservoirs, recreation, urban, or road uses. These shifts necessitate a more objective review of the potential of the remaining agricultural base to meet the goals enumerated by the State of Missouri and national requirements.

The proposed USDA projects will affect the physical landscape, environment, culture, and economy of the Basin. Not all these impacts can be quantified. In some instances, they are not readily identifiable and may not become apparent until a development program is approved and implemented. Through the use of sophisticated computer analyses, knowledge gained from past experience, and judgments as to the reaction of people to the proposed projects, estimates of the probable major impacts on the Basin could be made.

Proposals set forth in this report include considerations of treatments to maintain or improve the productivity of the Basin's agricultural land and the protection and conservation of its water resource. Action or inaction in one sector directly or indirectly affects the other. When possible, the impacts are presented on the basis of the physical and economic level of development "with" and "without" the proposed USDA program. In order to more clearly identify the impacts, the two basic segments of the program have been separated.

A. Land Treatment

This program sector consists of specific land treatment measures which, if applied, will reduce soil loss on the Basin's farm and forest land, reduce sedimentation in streams and reservoirs, and improve the economic and aesthetic factors.

According to 1968 CNI estimates, approximately 71 percent of crop, pasture, and forest land in the Basin needs soil and water conservation treatment (Table 62). By the year 2000, this projected figure drops to 63 percent under the USDA going programs. With additional development under the accelerated program, the figure is further reduced to 58 percent, indicating a reduction of 5 percent over and above accomplishments under going programs.

The application of land treatment measures such as: terracing, contour farming, strip cropping, protection from overgrazing, pasture improvement, hydrologic forest stand improvement, tree planting, and livestock exclusion from forest land is expected to materially reduce soil erosion and stream and reservoir sedimentation. These treatments, if installed, will help to prolong the effective life of planned reservoirs and, by reducing soil losses on agricultural lands, will help maintain soil fertility. Costs of agricultural production would also be decreased substantially.

An estimated 6,850 acres of flood plain forest land will be cleared when flood protection is provided. While this will have an adverse effect on wildlife habitat and timber production, there will be little impact on watershed protection. The shift of land now in agriculture, but unsuited to that use, to forest will offset the loss. Additional watershed protection benefits would be realized from the protected uplands.

Table 62. Estimated Present and Projected Land Treatment Accomplishments: South Grand-Osage River Basin, Missouri

	Projected Land Use By Year 2000	Accumulated Land Treatment By Year 2000	
		(Thousand Acres)	(Percent)
Cropland	2,172.2		
1968 CNI 1/		840.3	39
Going Program (Total Basin)		1,060.3	49
Accelerated Program on Early-Action Projects		1,215.7	56
Pasture	1,421.8		
1968 CNI		269.7	19
Going Program (Total Basin)		448.2	32
Accelerated Program on Early-Action Projects		520.8	37
Forest	2,211.3		
1968 CNI		561.2	25
Going Program (Total Basin)		651.1	29
Accelerated Program on Early-Action Projects		705.0	32
Total	5,805.3		
1968 CNI		1,671.2	29
Going Program (Total Basin)		2,159.6	37
Accelerated Program on Early-Action Projects		2,441.5	42

1/ Conservation Needs Inventory

Livestock exclusion on forest land and hydrologic stand improvement will increase timber quality and stocking levels, bringing the Basin closer to its true productive capacity. As inventory, growth, and quality of Basin forest land increase, its forest industries can fill a greater portion of their demand through the domestic supply rather than relying on "imports." The additional supply of wood fiber will enable industry to expand, creating more jobs in harvesting and primary and secondary manufacture.

Conversion of unprotected flood plains and suitable strip-mine land to walnut and pecan plantations managed for forage, nut, and high-quality wood fiber production can add additional income to the Basin and materially reduce the risk involved in cropping flood-prone land. 1/

Land treatment programs, including tree planting and grass seeding of land used for basic facilities around proposed recreation, municipal and

1/ Based on data supplied by the Missouri Conservation Commission, Division of Forestry and developed by USDA, Forest Service.

industrial structures, will enhance the recreation sites and provide additional water quality control.

B. Flood Prevention

All the 98 proposed structures in the early-action projects include flood prevention as a purpose. These structures will control a drainage area of 1,265 square miles or about 40 percent of the 3,179 square miles in the project area. About 320,100 acre-feet or 68 percent of the total proposed storage would be available for floodwater. In addition, 69.5 miles of channel improvement will provide additional flood prevention. These projects would reduce flooding on about 117,910 acres or 32 percent of the Basin acreage presently subject to flooding.

The proposed flood prevention projects would permit fuller utilization of the flood plain for agricultural production because of a reduction of risk and uncertainty on 117,910 acres. Two analyses were used to estimate the effect of the USDA's proposed early-action projects. The first analysis estimated the total impact of these projects and the second, the national impact.

1. Total Impacts

The initial impact of the proposed flood prevention projects on the Basin economy would be realized when construction begins and expenditures for goods and services within the Basin are made. This impact, however, would be short-lived and would dissipate when the construction was completed. The important impact is the long-run benefits to the economy derived from the flow of economic goods and services provided by the projects.

The first analysis determined the differences in conditions with and without the projects. In the watershed projects identified in the early-action program, this involved an economic-hydrology analysis utilizing rainfall, channel hydraulics, valley cross section surveys, and other basic input data to determine agricultural damage reduction benefits. Based on past experience of other watershed projects, land use changes and more intensive use of croplands also were evaluated.

Damages to crops and pasture are estimated to decrease by about $808,000 with the project; and other damages to fences, roads, bridges, etc. are expected to decrease by $195,000 (Table 63).

Table 63. Damage "With" and "Without" Early-Action Projects for 1980: South Grand-Osage River Basin, Missouri

Item	Without Project	With Project	Damage reduction with project
		(1,000 dollars)	
Crop and pasture	3,043	2,235	808
Other	482	287	195
Total	3,525	2,522	1,003

The initial benefits will be realized from construction.

In addition to the damage reduction benefits, are the estimated benefits because of more intensive and changed land use on the protected acreage. About 34,700 acres of cropland are expected to be farmed more intensively after flood protection, resulting in annual benefits of $345,610. Further annual benefits of $303,960 are expected from changing 1,830 acres of pasture and 9,770 acres of forest land to the production of corn and soybeans. Total annual benefits from damage reduction, more intensive land use, and changed land use are an estimated $1,652,310.

As mentioned in Chapter V, the total benefits from resource development may be greater than national benefits. This can occur if a larger share of the market can be captured from other areas producing the goods. If investments in resource development permit the Basin to produce more than its projected share and this increase in production is offset by a corresponding reduction in shares in another area, the economy of the Basin could benefit significantly; but national gains could be unaffected.

Crop and pasture benefits are defined as the net value of increased production made feasible through flood protection minus the increased on-farm costs of production. Thus, the assumption is made that additional quantities of agricultural products could be marketed from the Basin with no effect on prices. This is the usual assumption made implicitly when analyzing small local projects. The validity of the assumption depends not only on the competitive position of other areas now producing the goods but also the amount of resource development occurring in other areas. While one small development program such as that proposed for the Basin may have a negligible impact on markets and prices, the sum of all development programs across the United States can have a significant impact. Thus, a portion of these benefits derived under this assumption must be viewed as local benefits and should be used to justify projects to the extent that improving incomes, employment and the stability of the local economy are major objectives.

2. National Impact

The difference in costs of production "with" and "without" resource development is a measure of national efficiency gains or national benefits. A linear programming model was used to assess these national efficiency gains in agricultural production derived from the proposed flood protection program. The projected agricultural production requirements developed earlier in this report were used as target amounts of food and fiber to be met in future time periods from the resources of the Basin. Crop yields, fertilizer requirements, and costs of production data were developed for each economic soil resource group. Similar data were developed for flood, flood-free and flood-protected conditions for the bottom soils.

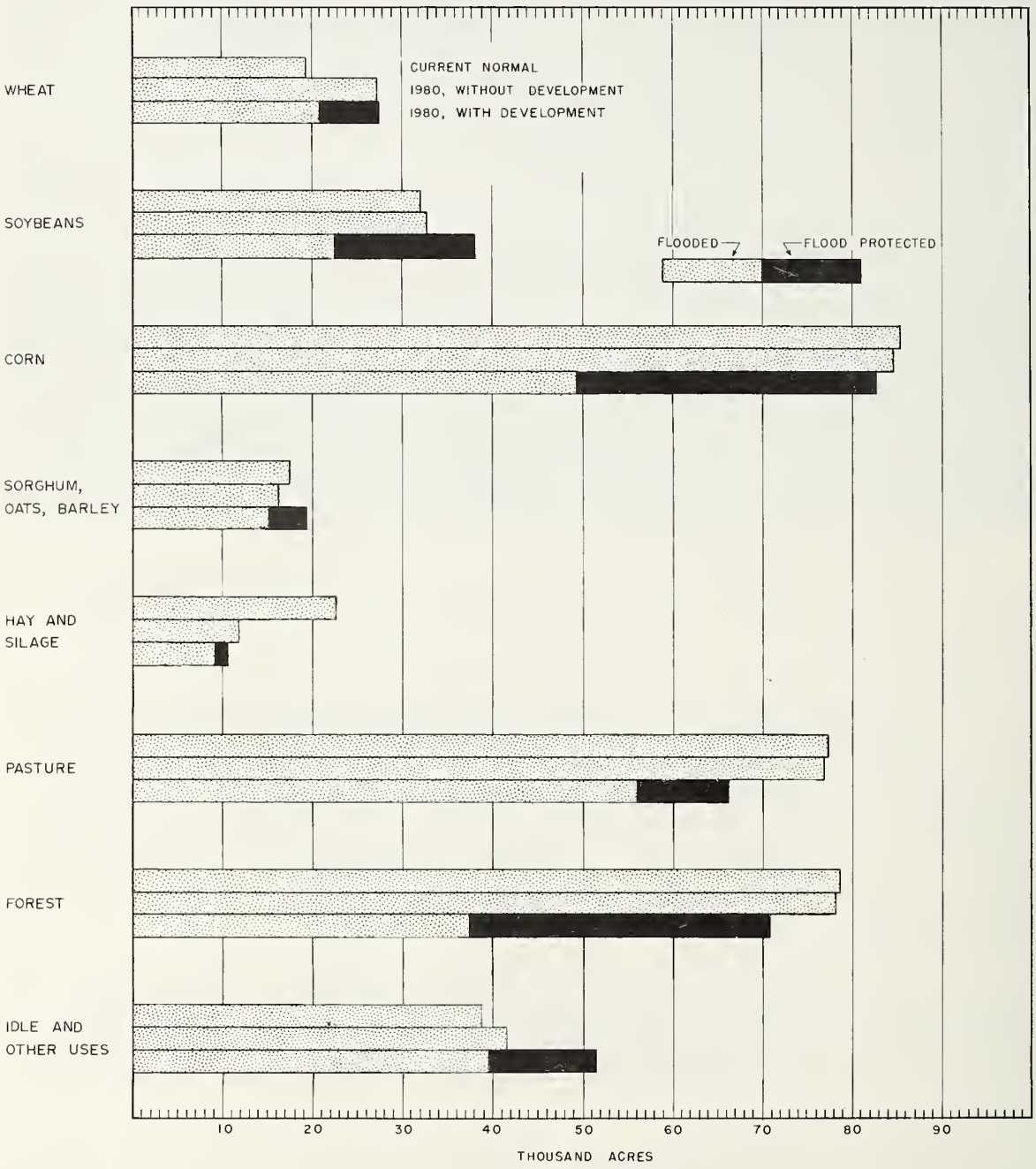
The linear programming model was used to determine the flood plain and upland land use needed to meet the projected agricultural production requirements at the lowest cost under "with" and "without" flood protection conditions.

Several constraints were imposed in order to more nearly reflect reality. These restrictions include: a) At least five percent of the land in each soil resource group would remain idle; b) The change in cropping patterns in each soil resource group was not allowed to vary by more than 50 percent of the current normal acreage by the year 1980 for most crops; c) Pasture and hayland acreage could increase but not decrease on soils subject to erosion. Other land uses could change due to economic factors; d) Up to 25 percent of the flood-protected forest acreage could be cleared for use as cropland or pasture.

These restrictions were made on the basis of past relationships and judgments as to the rapidity that farmers will adjust to future conditions. Constraint "c" implies that shifts in land use for erosion control in the upland areas will result in an increase in pasture and hayland in areas with erosive soils.

The current normal and projected land use in the flood plain for 1980 under conditions of "with" and "without" resource development are shown in Figure 13. Without resource development, the projected requirements for agricultural products could be met by increasing the flood plain acreage devoted to wheat and soybeans and reducing or maintaining the acreage devoted

FIGURE 13: CURRENT NORMAL AND PROJECTED LAND USE OF FLOODED ACRES FOR 1980, WITH AND WITHOUT FLOOD PROTECTION
SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI



to other crops. These shifts, along with shifts in land use in the upland areas, would enable the requirements to be met without resource development.

With resource development, a large acreage would be devoted to wheat, soybeans, and small grains. Corn would constitute the largest acreage on the flood-protected soils. About 6,850 acres of flood-protected forest land would be cleared and used for producing wheat, soybeans, corn, and small grains.

The above land use changes in the flood plain were made on the assumption that the projected agricultural production requirements represent the amounts that could be sold in national markets in 1980 at current normal prices. The requirements could be met with resource development at a reduced cost of production of $489,000 below costs without resource development. In addition, with resource development, more of the erosive soils in the upland areas could be converted to grass as more of the flood plain would be used to produce row crops formerly raised in the upland areas.

C. Recreation

A major multi-purpose use of the proposed early-action projects is recreation. Recreation facilities are proposed on 13 structures to meet the total 1980 recreational needs. Facilities on an additional 13 structures will be required by 2020.

The primary source of unsatisfied demand centered around the Kansas City SMSA. Although some of this demand can be satisfied outside the Basin, proposed, potential developments within the Basin can satisfy total needs. Thus, the proposed recreation developments should be considered only one possibility for final development. Water-based recreational use will require a water surface area of 9,318 acres and a total of 23,950 acres of land for reservoirs and facilities. These findings correspond closely with those in the Missouri Comprehensive Outdoor Recreation Plan.

The demand for water-based recreation and the resulting benefits from the alternative systems of potential reservoirs were evaluated by the use of a computerized econometric model as described in Chapter VII. Several combinations of reservoirs were evaluated, and the attendance and benefits from each combination were reviewed. Changes in the location and size of several reservoirs were made to derive the combination of structures in the proposed plan. Significant increases in benefits ranging from 24 to 46 percent were realized by modifying the initial combination of structures. Costs of facilities remained almost constant for the alternate systems evaluated.

In the proposed program, 26 reservoirs built by 1980 will include water storage for recreation. However, full development of basic facilities is not justified for 12 of the reservoirs until 2000, and one until 2020. Rather than preempt the sites with single purpose flood prevention reservoirs, all 26 were included in the short-range program; however, basic facilities were determined on 1980 needs. Annual recreation benefits for 13 multiple purpose structures in 1980 are approximately $2 million. Construction of basic facilities at 12 additional reservoirs will increase annual benefits to $4.2 million by 2000. Annual benefits of $4.9 million will be realized with development of the final site in 2020. Recreation benefits realized in 2000 and 2020 were discounted

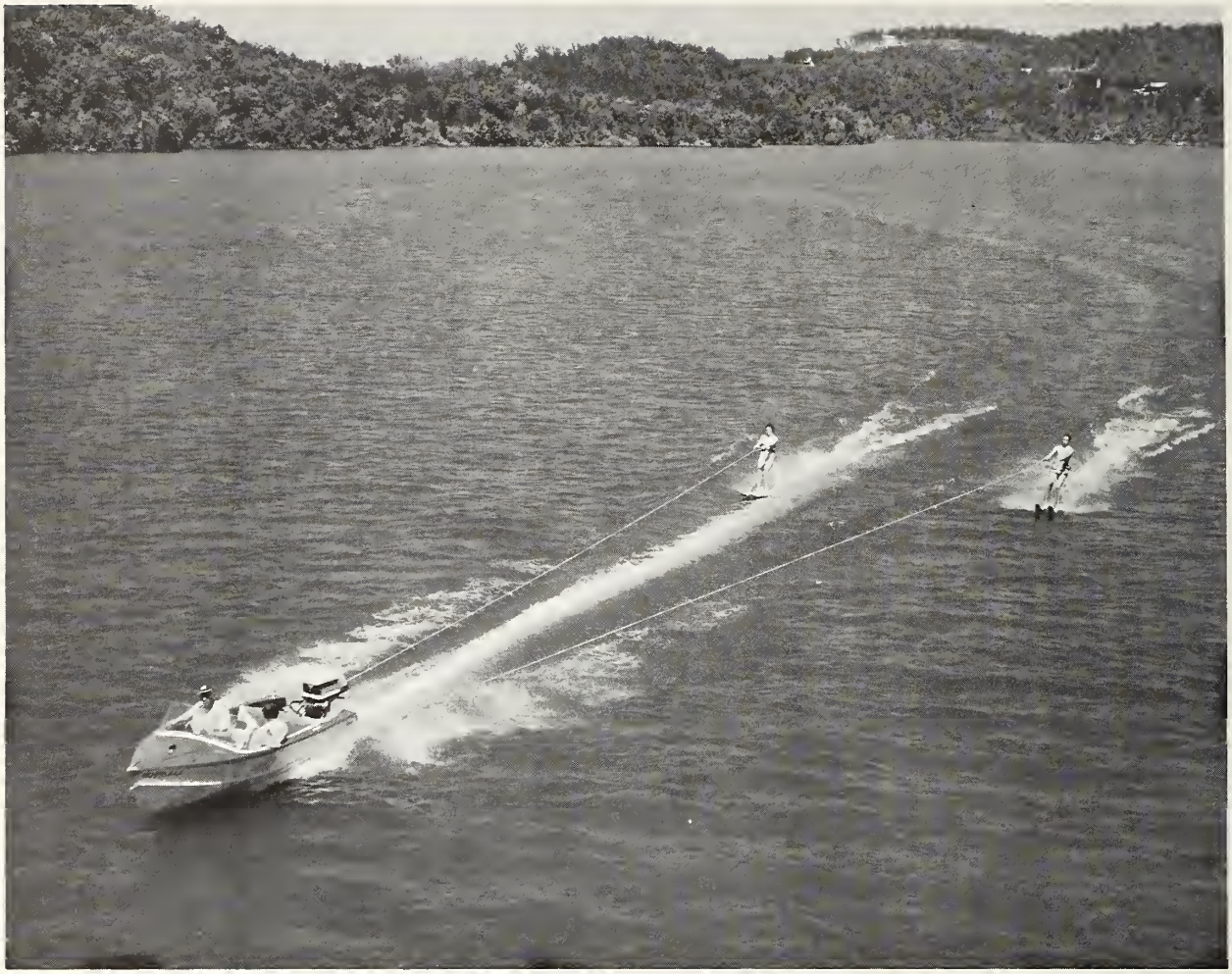


Photo by: Walker-Missouri Tourism

Over 3.2 million recreation days will realize 4.9 million dollars in annual benefits by 2020.

and amortized over the life of the structure to determine their present annual value. Total annual recreation benefits for the 26 reservoirs are $3,756,030 (Table 64). Discounted future benefits and $398,000 secondary benefits allocated to recreation are included.

The higher recreation benefits for future time periods are a result of higher income, increased participation rates, and increased population.

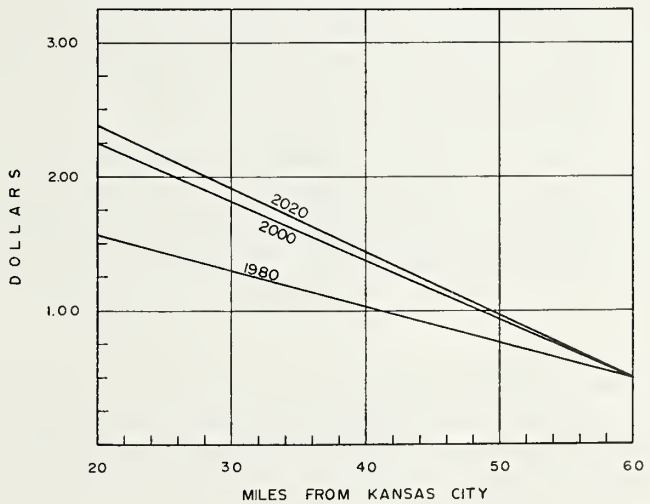
The importance of close proximity of the structures is illustrated by Figure 14. These curves indicate the relationship between recreation benefits per recreation day and the distance of proposed structures from Kansas City.

Table 64. Summary of Costs and Benefits by Purposes: South Grand-Osage River Basin, Missouri

Item	Total Installation Costs	Annual 1/ Amortization Costs	Annual O & M Costs	Total Annual Costs	Total Annual 2/ Benefits	Average B:C Ratio
		(Dollars) 3/				
Single Purpose						
Flood Prevention	11,797,210	580,120	20,640	600,760	899,040	1.5:1.0
Multiple Purpose						
Flood Prevention	4,970,050	244,380	9,690	254,070	737,300	2.9:1.0
Municipal & Industrial	1,420,200	69,810	1,770	71,580	78,740	1.1:1.0
Recreation						
Water Resources 4/	8,707,700	428,150	4,990	433,140		
Public Development	15,847,800	578,870	586,700	1,165,570		
Total Recreation	24,555,500	1,007,020	591,690	1,598,710	3,756,030	2.3:1.0
Multiple Purpose - Channel						
Flood Prevention	6,562,100	322,660	113,660	436,320	354,950	0.8:1.0
Drainage	547,100	26,900	9,620	36,520	51,600	1.4:1.0
Subtotal	49,852,160	2,250,890	747,070	2,997,960	5,877,660	2.0:1.0
Project Administration				279,460		
TOTAL	49,852,160	2,250,890	747,070	3,277,420	5,877,660	1.8:1.0

1/ 4 7/8 percent interest @ 100 years
2/ Includes Secondary Benefits
3/ Price Base 1967
4/ Includes Special Recreation Cost

FIGURE 14: NET RECREATION BENEFITS PER RECREATION DAY
BY DISTANCE OF STRUCTURE FROM KANSAS CITY
SOUTH GRAND - OSAGE RIVER BASIN, MISSOURI



The use of the recreation model results in an improved location of the reservoirs in respect to the population and a schedule of construction for various time frames to better meet the needs of the future increased populations.

The value per recreation day falls within the range of those set out in Supplement No. 1, Evaluations Standards for Primary Outdoor Recreation Benefits, Ad Hoc Water Resources Council, Washington, D. C. dated June 4, 1964.

The benefits enumerated above can be considered national benefits, since these values represent savings in cost from having the recreational facilities close to the population centers. Additional regional and local benefits would accrue due to the economic activities stimulated through use of the facilities. Although these benefits were not evaluated, the construction of the recreational facilities would have an important impact on the local and regional economy of the area.

D. Water Supply

Storage capacity of 29,500 acre-feet for municipal and industrial water supply is planned in 16 multi-purpose structures to serve 22 towns. This supply would serve 72,900 people, the projected population of these towns by the year 2020. This estimate is, of course, subject to a high degree of error because of the difficulty of anticipating the growth of specific small towns and small communities.

In most cases, present supplies for the communities are sufficient. However, the consequences of not having a dependable source of water for potential needs can severely restrict the growth of these communities. Multi-purpose storage reservoirs, in many cases, would provide the most economical source in the long run for anticipated needs.

Average annual water supply benefits of $72,000 were based on the cost estimates of providing storage in multi-purpose structures. Benefits would be much higher in those cases where growth would be restricted because of a lack of adequate quality water.

E. Drainage and Irrigation

Agricultural drainage as a project measure comprises only about one percent of the total benefits and costs of the early-action projects. Although the multiple purpose channel improvements are primarily for flood control, about eight percent of the cost and 13 percent of the benefits are allocated to drainage.

The impact from drainage development is realized when full production potential is reached. Surface field drains associated with land enhancement provide about two-thirds of the drainage benefits. On 3,345 acres of wetlands, channel improvement provides both drainage and flood protection benefits.

The most significant impact from drainage on both bottomland and upland soils will be accomplished as part of the land treatment program. About one-fourth of the total drainage needs, or 24,350 acres, can be adequately met

with existing outlets by the year 2000. Of this, about 17,000 acres are located within the early-action watersheds.

The long-range impact of irrigation developments is unknown. Present trends show an increasing amount of interest developing in the claypan soils areas. The primary effect of irrigation development will be to the individual farmer who will benefit from more stable production and income.

F. Redevelopment and Secondary Benefits

The projects proposed within the Ozark Economic Development Region and the Resource Conservation and Development areas will aid in accelerating the economic growth of this area. Part of eight watersheds having 28 structures are in these areas. The added employment and utilization of the local labor force during project installation and operation and maintenance is expected to bolster the economy by $21,660 annually.

An annual benefit of $727,200, over and above the immediate products or services of the project, is expected as a result of activities "stemming from" or "induced by" the project. These benefits arise from the profits realized by enterprises transporting, processing, and marketing the increased production of goods from the project.

The profits from supplying increased goods and services used in production is an impact induced by the project. The profits from increased sales of seed and fertilizer to producers of the project area are examples of the benefit. Likewise, "induced by" secondary benefits would accrue to service stations, hotels and motels, grocery stores, and other establishments that supply goods and services to those enjoying recreational developments of the project.

G. Land Use Availability

Construction of the proposed water resource projects would result in a reduction of about 58,760 acres in the land base available for agriculture and forestry. About 2,980 acres would be needed for stream channel improvement, 14,060 acres would be required for permanent pool water storage area, and 23,950 acres around the lake areas would be used for recreation facilities; the remainder would be temporary flood pool and would have limited use as agricultural land. The majority of the acreage, 39,000 acres, is in Land Resource Area 112; the remainder is in LRA 116.

H. Fish and Wildlife

Fish and wildlife will be affected by the changes in water flows and land use resulting from the USDA program. Wildlife habitat in the flood-protected areas will be changed because of more intensive use of these lands for agricultural purposes. This will be partially offset by an expected increase in habitat for wildlife in upland areas.

Although channel improvement will have detrimental effects to the stream fishery, attention during design and construction can reduce these damages. When alternates to channel improvement are not feasible, mitigation of losses

should be part of the project. The permanent storage pools of 14,048 surface acres will increase the lake fisheries. Public access to the multi-purpose recreation lakes will insure the availability of 9,308 acres of this fishery to the people. The remaining 4,740 acres of multi-purpose water supply and single purpose flood prevention pools will have limited use. Access may be limited to protect water supplies or it may be controlled by landowners on single purpose structures. Water quality in streams will be enhanced by the structural and land treatment measures.

I. Social and Institutional

Construction of the water resource development projects will have definite social and institutional impacts. Organization of groups interested in the various purposes of water resource development will be necessary before detail planning and construction can be completed. Once the projects are constructed, recreation is expected to be an important activity, and the social values of the area will be affected. The development of access roads to the reservoir sites will further accelerate the trend in population movement into the Basin, particularly in the area adjacent to Kansas City. More retirement and summer homes can be expected if the water resources program is completed.

X. COORDINATION, IMPLEMENTATION, AND PROGRAMS FOR FURTHER DEVELOPMENT

This report has dealt with the analysis of the Basin's water and related land resources, the population utilizing these resources, and the problems and attendant factors affecting the Basin potential to provide for future water, food, and fiber needs.

The action set forth herein may or may not prove practical as a way to meet the projected needs. Successful implementation will depend on coordinating with proposals of other Federal, State, and local agencies and upon acceptance by the people. The legislative process may be necessary to remove local constraints or expand program purposes. Coordinated efforts will help implement these programs and will provide for the orderly development of the Basin's water and related land resources.

A. Coordination

Water and related land development in the South Grand-Osage River Basin can be accomplished under programs administered by two Federal agencies--the Corps of Engineers and the Department of Agriculture. In addition, development of resources and the regulation of resource utilization are accomplished in varying degrees by State and local government.

The Department of Agriculture has completed this study of the resource base and its relationship to present and future inhabitants of the Basin.

Soil and Water Conservation Districts, with technical assistance provided by the Soil Conservation Service, have initiated soil conservation practices in some counties of the Basin; and eventual expansion of this program to cover the entire Basin can be expected. Some local interest has been expressed in watershed development under the provisions of Public Law 566, even though no operating watersheds now exist within the study area. The Forest Service, with the Missouri Conservation Commission, affords landowners with assistance in matters relating to forestry and fire protection.

In addition to the Federal programs and Federally-sponsored programs, the Missouri State Park Board and the Missouri Conservation Commission acquire and manage land for recreation and fish and wildlife purposes. The Missouri Council for Outdoor Recreation has prepared an Outdoor Recreation Plan for the State and encourages local government to provide recreation areas and development with assistance from the Land and Water Conservation Fund distributed through the Federal Bureau of Outdoor Recreation.

The laws of Missouri provide for the establishment of special benefit districts and authorizes the construction of flood control and drainage improvement by such districts. Private efforts to regulate and control water, while not supervised by the State, contribute materially to the overall hydrological condition and affect the Basin resources.

Although the program proposed in this report consists entirely of activity within the State of Missouri, approximately 4,300 square miles of the drainage area lies upstream in the State of Kansas. It is, therefore, necessary to consider the downstream effects of works of improvement occurring in Kansas as the suggested program is implemented in Missouri.

The Missouri Water Resources Board is charged with developing a long-range program for the conservation, development, management, and use of the water resources of the State. Some coordination of effort can be accomplished through the Board as individual projects are planned. Added effort to assure proper development must be made by Federal and State agencies, by local government, and by individuals as improvements are contemplated and carried out. This can be accomplished by making public those actions capable of effecting material change on the land and water resource base. Often, multi-purpose programs can be implemented to serve a greater number of interests at less unit cost when knowledge of specific functional purposes and desires are widespread. Activities of all State, Federal, and local agencies or interest groups should be carefully screened and analyzed in order to reduce costly duplication and promote complementary actions aimed at obtaining a fully integrated resource management development program.

B. Implementation

In many instances, programs are presently available for meeting many of the Basin's needs. The opportunity for Federal assistance to obtain greater returns from the resource base was presented in Chapter VIII, Opportunities for Development of USDA Programs. These opportunities are not always being utilized. This may be partially due to (1) lack of knowledge or interest in the programs, and (2) fiscal or legislative limitations inherent in the existing programs. If resource utilization is to improve, the people will need to accept and support the concept of resource management. Initial acceptance must be with each individual; and ultimate support must be through group action, either by political subdivisions or private organizations. Group participation is essential for implementation by permitting democratic decision on those features of the improvement program that affect or serve more than the individual.

1. Information and Education

Information and education services offered by various State and Federal agencies cover a rather broad spectrum of interests. They range from conservation practices through home economics to agricultural production economics. Regardless of area interest, they are aimed at improving the conditions existing on the Basin's farms or in rural areas. Program and information services of various State and Federal agencies should be improved and intensified in order to bring the conservation message to a greater number of people in a manner that provokes interest and stimulates activity.

An excellent example of this type activity is the nationally known Smokey Bear Fire Prevention Campaign. Professionally administered, this advertising program has probably done more to reduce the rate of wildfire damage than any other Forest Service program.

Another good example is the Soil Stewardship Program, sponsored by the National Association of Soil and Water Conservation Districts, which promotes responsible stewardship of the Nation's soil and water resources through local church programs.

Eventually, the effective development and management of water and related land resources will require a consolidated approach through group planning and application of solutions. Existing laws, which permit cities, towns and special benefit districts to enter the field of resource development and management stress local initiation of their application. The implementation of the proposals of this report, which are designed to improve living conditions for the residents, rests solely with those residents. State and Federal agencies can provide consultative and technical services, but these alone cannot and will not accomplish the efficient use of resources without community and group-initiated action. Local individual leadership needs to be stimulated and their influence used to promote conservation.

2. Modification of Existing Programs

Many programs designed to enable agricultural landowners to practice conservation on their farms and forest land are in existence. Through the years, these programs have either become outdated due to rising costs or changing technology or have been modified through interpretation and usage so as to render them relatively ineffective. In some instances, they are not broad enough to cover situations which have arisen since their inception. It is imperative that the existing programs be reviewed and updated in order to increase their effectiveness.

a. The Agricultural Stabilization and Conservation Service currently administers, on a cost-sharing basis, a program of land treatment and improvement. Increased emphasis placed on some of the existing permanent or long-range measures would materially improve watershed protection. The addition of new practices will increase even further the Service's effectiveness in serving the people and promoting the conservation of the Basin's water and related land resources. The recent announcement of a cost-sharing program for waste treatment facilities for livestock feedlots and concentration yards is an excellent example of this.

b. Land treatment programs on areas upstream from reservoirs should be modified in order to provide the best possible protection to the reservoir. This treatment will vary depending upon reservoir use.

(1) Flood control structures should be protected from siltation. Land treatment would include the conversion of critical upstream areas to forest or grassland. Emphasis would be placed on reducing the sediment yield. Agricultural activities, including cropping and livestock production, would be permitted on noncritical areas.

(2) Structures intended for recreation or municipal and industrial water use require different treatment. Pollution from animals, insecticides, or fertilizers should be reduced more fully. Practices such as cropping and grazing would be allowed on the more remote watershed areas. Land immediately adjacent to the impoundment would be well protected by forest and grassland filters. Municipal and industrial water sources require maximum protection. Upstream areas should be devoted to forest or wildlife use to insure high quality, raw water supply.

c. On larger flood control structures administered by the Corps of Engineers, the land treatment program is limited to that provided by the Department of Agriculture under going programs. Land treatment measures on the area above these reservoirs are not planned in conjunction with the reservoir, but come about as independent actions taken by individual landowners. The inclusion of specific land treatment problems and programs above these structures could significantly increase the effectiveness of the installation, and prolong its usefulness. This rationale should be extended to include all public reservoirs.

Accelerated land treatment presently offered in watersheds qualifying under Public Law 566 should also be made available on these lands. Regardless of administration, the projects are financed by, constructed for, and provide benefits for the public.

d. The Missouri State Forestry Law should be updated to reflect more accurately rising land values. The present maximum land value of $10 per acre is extremely low, especially in agricultural areas.

C. New Programs Needed

Changes in present authorities, as well as new programs, are needed in addition to the present authorities available to develop the resources in the Basin.

1. Emphasis is needed on a program to promote the shifting of present improper land use to uses that meet the land's capabilities. This could include cost-sharing on clearing forest or brushy areas better suited to farming and/or the forestation of crop and pasture land better suited to forest or wildlife use.

2. A very effective approach to land treatment and use adjustment would be a program similar to that authorized under the Great Plains Act of August 7, 1956. The Secretary of Agriculture was authorized to enter into contracts with producers in the Great Plains area to assist farm and ranch owners to make orderly and progressive changes in cropping systems and land uses needed to conserve the soil and water resources. An approach of this type applied Basin-wide could provide the vehicle for increasing land treatment and production stability.

3. Incentives should be provided for Basin landowners to properly manage existing forest land or woodlots. One approach could be a subsidy to manage forest land for timber or nut production, watershed protection, recreation, or environmental enhancement. An example would be payments to landowners for value foregone such as the forage value of a woodlot. This would provide the stimulus to exclude damaging grazing and other harmful practices.

D. Alternative Considerations

In addition to the above changes or new programs, additional emphasis should be placed on other opportunities for developing resources as discussed in the following sections.

1. Zoning and Land Use Management

County land and water regulatory organizations are needed. County Planning and Zoning Commissions established under law and working with State and Federal agencies could plan for efficient and optimum use of water and related land. These commissions should have the legal authority to negotiate land easements, contract for services, levy taxes, and make zoning decisions to provide for the beneficial use of the resources while protecting public and private investment.

The U. S. Department of Housing and Urban Development currently sponsors a joint venture between the Federal Government and the private insurance industry whereby qualifying residential and business properties existing in flood hazard areas will be eligible for flood insurance at reduced rates. New properties would have to pay the unadjusted premiums. This program will be effective only if local or State organizations take the proper steps to provide zoning that will reduce or prevent future flood damages.

Land use planning expertise is needed to provide highway designers and urban developers with physical information which will enable them to provide adequate safeguards to the Basin's fragile water and land resources. The Soil Conservation Service can provide soils data pertaining to the physical suitability of soils for road or house building, construction of sanitary disposal systems, drainage characteristics, and other information about the capabilities of the soils for non-agricultural use. Very little use is made of this service. Specific legislation or ordinances requiring soil suitability surveys to be made would insure more satisfactory developments.

2. Economic Development

The decrease in population and low per capita income is a reflection of the under and inefficient utilization of the Basin's resources. Additional study by Rural Development Committees could pinpoint industrial expansion potentials in the agricultural, forestry, or recreational segments of the economy and provide impetus for attracting related or service industries. Close proximity to several large metropolitan centers indicates that a comparative advantage in some economic endeavors may be enjoyed by the Basin. These possibilities should be explored and findings made available to interested State and local groups.

Currently, the annual output for wood-using industries is appreciably higher than the annual timber cut. Select species such as black walnut and other premium hardwoods are being imported. This is due primarily to the low quality of the timber in the area's forests.

The establishment of markets for low-grade materials for charcoal, pallet, flooring, or pulp material would provide additional income to forest landowners. By 1980, projections indicate that more timber will be cut than will be utilized by the wood-using industries. This requires export of wood fiber. If processed within the Basin, this material could return two to four times the value it will bring as a raw export commodity. Additional wood-using industries to meet the short and long-term needs would provide increased employment and income and would tend to reduce population outflow.

3. Environmental Quality Control

In this age of natural landscape use and modification, the task is one of achieving balanced development between intrinsic and extrinsic values. The objective in rural areas should be the identification, preservation, and protection of the most outstanding natural values and insuring that man-made values, once introduced, are developed in harmony with the environment.

While the flat-to-rolling farmlands of the Cherokee Prairies and the expansive forest patterns of the Ozark Highland have their share of beauty, the streams, valleys, bluffs, and ridges are the primary scenic areas that combine to form the unique environmental diversification in the Lower Basin.

Identification of these areas and the evolution of coordinated development plans, both within them and along their fringes, will insure against misuse and/or extensive and expensive rehabilitation by future generations.

4. Fish and Wildlife

The demand for hunting and fishing areas is increasing. Private land has a potential for meeting most of this need if the landowners were willing to develop and grant access. Programs providing economic return for the hunting and fishing use of their land could remove the barriers. Such reimbursement could be cost-shared by the State and the users. The landowners would be expected to use a portion of the income to provide new or improved fish and wildlife habitat. Additional development might be fostered by providing a tax incentive for land so managed.

APPENDIX

GEOLOGY, MINERAL RESOURCES & ENGINEERING GEOLOGY

GEOLOGY, MINERAL RESOURCES & ENGINEERING GEOLOGY OF THE SOUTH GRAND-OSAGE RIVER BASIN, MISSOURI

Prepared by
Mineral Resources and Engineering Geology Sections
Missouri Geological Survey & Water Resources
Rolla, Missouri
June, 1969

INTRODUCTION

A general discussion is given of the geologic units, mineral resources, and engineering problems related to rock and soil conditions within the South Grand-Osage River Basin in west-central Missouri. There was no field work directly related to the report, and data presented are based on information on file at the Missouri Geological Survey, Rolla, Missouri.

The Basin is subdivided into seven areas and the geology of each is discussed. Exposed bedrock ranges in age from Late Cambrian through middle Pennsylvanian. Dominant rock types in the Basin are shales, clays and sandstones in the west; cherty limestones and dolomites in the central part; and cherty dolomites and sandstone in the east. Bedrock is essentially flat lying, exhibiting mainly regional dip to the northwest. A number of faults and other structural features are present.

The distribution, production, and economic importance of the mineral resources are discussed. Locations of active operations are shown on Map 5, page 11 in the main report. Since 1954, the annual value of mineral production has been in excess of $10 million. Mineral commodities being exploited are: coal, stone, sand, gravel, barite, and crude oil. Two commodities, coal and crushed stone, represent more than 90 percent of the total value of mineral production.

Engineering problems within the Basin are directly related to the distribution of bedrock and soil types. Soil thickness and physical properties vary considerably depending on degree of slope and the underlying bedrock. Permeability and bedrock type influence structural stability, pollution potential, and soil characteristics. Detailed investigations of the geology and soil are necessary for most development projects in the Basin area.

For additional information the reader is referred to the following Survey publications:

Vol 40, The Stratigraphic Succession in Missouri, 1961
Vol 43, Mineral & Water Resources of Missouri, 1967
Geologic Map of Missouri, 1961
Mineral Resource & Industry Map of Missouri, 1965

Requests for the above or specific information should be directed to the Missouri Geological Survey, Box 250, Rolla, Missouri 65401.

GEOLOGY

Bedrock within the South Grand-Osage River Basin is assigned to the Cambrian, Ordovician, Mississippian, and Pennsylvanian Systems. The Cambro-Ordovician rocks are predominantly cherty dolomite and the Mississippian rocks cherty limestones. The Pennsylvanian consists of cyclic alternating deposits of sandstone, shale, clay, limestone, and coal.

The Basin is divided into seven regions on the basis of the distribution of geologic units. These regions, designated by Roman numerals, are delineated on Map 4, Generalized Geologic Map (page 10 in the main report). Areas I, II, III and IV are underlain by Pennsylvanian strata; Area V by the Mississippian; and Area VI and VII by the Lower Ordovician. A few small outcrops of uppermost Cambrian dolomite are exposed in Area VII.

The major structure in the Basin is the Proctor anticline which brings Upper Cambrian dolomite to the surface in the Lake of the Ozarks region (Area VII). A number of faults and other structural features are present within the Basin, especially in the south-central part. Southwest of Decaturville, Camden County (Area VII) there is a well developed ring structure about four miles in diameter. The central core is intensely brecciated and a Precambrian granite is exposed. Outside the structure, the Precambrian lies some 1,500 feet below the surface. The exact origin of this cryptoexplosive structure is not known but has been attributed to either meteoritic impact or deeply buried volcanic explosion.

AREA I

Located in western and northwestern Cass County, this area is underlain by alternating strata of shale, limestone, and clay assigned to the Kansas City Group of the Pennsylvanian System. This Group contains a number of prominent limestone members, the most important of which are the Bethany Falls, Winterset, and Argentine. Each has a thickness of 15 to 20 feet with the Argentine ranging upwards to 40 feet. The Argentine caps much of the upland area in the northwestern part of the county. The Bethany Falls limestone forms a prominent escarpment which is essentially coincident with the boundary of Areas I and II. Shale layers range from 10 to 20 feet in thickness and contain interbedded siltstones and sandstones.

AREA II

Area II, a narrow belt of Pennsylvanian shales and sandstones, roughly parallels Area I from northern Bates County through Cass County into the northwestern corner of Johnson County. Bedrock is assigned the Pleasanton Group which comprises all the rock units underlying the Kansas City Group and overlying the Marmaton Group. The Pleasanton includes a channel-fill sandstone, the Warrensburg, which extends into the northern part of Area II. The average thickness of the Pleasanton Group is about 90 feet; where it includes the channel deposit, it exceeds 150 feet.

AREA III

The Area is a relatively narrow, odd-shaped band approximately parallel to Areas I and II and extending from northern Bates County through eastern Cass into Johnson County. It is underlain by strata of the Marmaton Group. This Group, bounded by the Pleasanton above and the Cherokee Group below, consists of a succession of alternating shale, limestone, sandstone, clay, and coal. Thick (5 to 15 feet) limestones in the Marmaton are the Blackjack Creek, Higginsville (frequently referred to as the "Fort Scott Limestone") and Myrick Station. The Higginsville is the most prominent and forms an escarpment in Vernon and Bates Counties where it reaches a maximum thickness of 25 feet. Sandstones and shales range from 10 to more than 25 feet in thickness. The topography in Area III is emphasized by the type of bedrock prominent at various elevations. The thicker shales produce rolling topography. Where limestones crop out, rough topography can be expected. With the exception of the Higginsville, the limestones in the Marmaton Group do not produce escarpments that can be traced for any great distance.

AREA IV

Area IV is the largest of the areas underlain by Pennsylvanian strata. It is a broad belt of predominantly sandstones and shales extending from northern Barton County northeastward through Vernon, southeastern Bates, western St. Clair, and Henry Counties. Bedrock is assigned to the Cherokee Group which is subdivided into two subgroups: the Cabaniss (upper) and the Krebs (lower).

Rocks assigned to the Cabaniss Subgroup are sandstones, siltstones, shales, clays, thin limestone, and coals. The Cabaniss outcrop belt is along the western one-third of the Area. Small outliers are present in the outcrop area of the Krebs. Thickness of the Subgroup ranges from 150 to 200 feet.

The lithology of the Krebs Subgroup is similar to that of the Cabaniss with the exception that limestone units are lacking. Sandstones, the dominant lithology, shales, clays, and coals comprise the Subgroup. Thickness of the Krebs varies but it is estimated to average 150 feet in the Area.

Included in Area IV are pre-Cherokee Pennsylvanian deposits of shale, clay, and limestone. These deposits are discontinuous in extent and quite variable in thickness.

AREA V

The major portion of this Area lies in the south-central part of the Basin in Greene, Dade, Cedar, and southwestern Polk Counties. A smaller area extends from northern Polk County northward through western Hickory and eastern St. Clair into southeastern Henry and western Benton Counties. A number of outliers, some of significant size, are present to the east in Area VI. Bedrock, principally limestone, is assigned to the Meramecian (Youngest), Osagean, and Kinderhookian Series of the Mississippian System. The lithology of the Meramecian and Osagean Series is similar in that both are largely massive, medium to coarse grained, fossiliferous limestones. Chert, while present in both, is not nearly so abundant in the Meramecian as in the underlying

Osagean. The Kinderhookian consists of three distinct rock types; an upper siltstone, a middle dolomite and dolomitic limestone, and a lower limestone.

The principal outcrop area of the Meramecian is along the southwest margin of Area V in Cedar and Dade Counties. Thickness ranges from 50 feet to more than 100 feet. The Osagean Series underlies the greater part of Area V. Thickness of the Series varies from about 400 feet along the southern margin to approximately 200 feet in the north. The Kinderhookian extends throughout Area V along its border with Area VI. The Series is represented by the Chouteau Group which ranges from nearly 100 feet at the south to about 50 feet in the north. In the southern area, the Group consists of a finely crystalline limestone overlain by a siltstone and shale. Northward, the siltstone and shale grades into and interfingers with a cherty, shaly dolomitic limestone, which then becomes the dominant unit. The siltstone and shale unit ranges from 80 feet at the south to less than 10 feet at the north. The principal area of transition from clastic to carbonate is Hickory County.

AREA VI

The Area consists of a north-south belt extending through the central portion of the Basin and a narrow, upland region along its east and southeast margin. Bedrock is assigned to the lower Ordovician Canadian Series and consists of the Jefferson City (lower) and Cotter (upper) formations. Both are dolomites containing varying amounts of chert. A characteristic lithology is a finely crystalline, argillaceous dolomite termed "cotton rock." Shales and sandstone, while present, are minor elements. Thickness of the Jefferson City-Cotter in the outcrop area is estimated to range from 100 to 300 feet.

AREA VII

This Area encompasses the most rugged and highly dissected portion of the South Grand-Osage River Basin. Bedrock, the oldest exposed within the Basin, is assigned to the Lower Ordovician (Canadian) and Upper Cambrian. In descending order, the Roubidoux and Gasconade formations represent the former; the Eminence formation the latter. The dominant lithologies are cherty, crystalline dolomites and quartz sandstones. Sandstone beds are present in the Roubidoux and at the base of the Gasconade. Combined thickness of the Roubidoux - Gasconade formations ranges from 400 feet to slightly in excess of 500 feet. Although thickness of the Eminence is about 275 feet, only the upper 25 to 50 feet is exposed.

In Area VII the sequence between the base of the Gasconade and the top of the Precambrian consists of from 900 to 1,200 feet of dolomite underlain by 200 to 300 feet of sandstone. Within the Basin, the top of the Precambrian ranges from a depth of approximately 1,500 feet in the eastern portion to more than 2,500 feet in the west.

MINERAL RESOURCES

Introduction

Mineral deposits within the South Grand-Osage River Basin are mineral fuels, non-metals and metals. Only mineral fuels and nonmetallic minerals are of present economic importance. The principal resources are coal and stone. Others are: asphaltic sandstone, sand and gravel, clay and shale, crude petroleum, dimension sandstone and barite. None of the known metallic mineral deposits--iron, lead, and zinc are being mined. The locations of known mineral producers in the Basin are shown on Map 5 (page 11 in the main report).

The following counties were used for statistical data:

Barton	Camden	Dade	Henry	Miller	St. Clair
Bates	Cass	Dallas	Hickory	Morgan	Vernon
Benton	Cedar	Greene	Laclede	Polk	

VALUE

The annual value of mineral production for the 16-year period 1952 thru 1967 has ranged from $8.6 million in 1952 to a high of nearly $13.5 million in 1965. Four counties reported an annual mineral value in excess of one million dollars during the period--Bates (1952 thru 1957), Greene (1952 thru 1967), Henry (1952 thru 1967), and St. Clair (1952 & 1955 thru 1964). The annual mineral value in Greene County has risen from $1.5 million in 1952 to $3.7 million in 1967. Mineral commodities contributing to the high values in these counties are lime and crushed limestone in Greene County, and coal and crushed limestone in Henry County. Values in Bates and St Clair Counties declined by more than one million dollars each when coal mining was curtailed.

Coal and crushed stone are the major mineral commodities being produced in the Basin. The annual value of each has been in excess of one million dollars for more than 10 years and combined, they represent more than 90 percent of total annual value.

Table 1. Annual Value of Mineral Production: South Grand-Osage River Basin Missouri

	(Million Dollars)		
1952	8.658	1960	12.417
1953	9.285	1961	11.569
1954	9.450	1962	11.949
1955	12.426	1963	12.567
1956	12.841	1964	13.128
1957	12.275	1965	13.422
1958	11.072	1966	13.338
1959	11.756	1967	13.024

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Lime production from Greene County is included in the above totals; however, the manufacturing plant located near Springfield lies outside the Basin.

Table 2. Production by Mineral Commodities for Selected Years: South Grand-Osage River Basin, Missouri

		1955	1960	1967
Asphaltic sandstone	(tons)	-W-	-W-	-W-
Clay & Shale	(tons)	-W-	-W-	-W-
Coal	(tons)	2,284,656	1,934,827	-W-
Oil	(bbls)	12,867*	8,179*	-W-
Sand & Gravel	(tons)	331,829	253,176	82,000
Stone	(tons)	1,440,400	1,611,040	2,123,063

-W- Withheld - company confidential data.
* Includes production from southern Jackson County

The distribution of many of the mineral resources and commodities within the Basin are directly related to the areal geology. Thus, in the following discussion of the various mineral commodities, the reader is referred to the seven areas outlined on Map 4, Generalized Geologic Map (page 10 in the main report).

Mineral Fuels

Coal: The bulk of the coal production is consumed within and in areas immediately adjacent to the Basin. Major consumers are electric steam-generating plants. Kansas City Power & Light Company's 540,000 KW Montrose Station plant, located in the South Grand River Subbasin (Henry County), consumes approximately 1.75 million tons of coal annually. Coal is strip mined adjacent to the generating plant and in the Calhoun area by Peabody Coal Company. Construction of the Empire District Electric Company's 200,000 KW plant in Jasper County, 15 miles south of the Little Osage Subbasin, will require an estimated 750,000 tons of coal annually. The Pittsburg-Midway Coal Company will supply this tonnage from a strip mine in the southwestern corner of the Little Osage Subbasin (Barton County). Construction of the generating plant and development of the mine are underway. Coal resources are located in the western one-third of the Basin (Areas I, II, III, and IV) and include two of the State's major coal fields--the Southwest Field (Bates, Vernon, and Barton Counties) and the Tebo Field (principally in Henry County but including portions of southeastern Barton, northwestern St. Clair and southeastern Johnson Counties). The major stripable coals are located in Area IV. Coal reserves in Areas I and II are deeper--200 to 600 feet plus, and in most instances would require shaft mining. Coal beds within the Basin range from a few inches to as much as six feet in thickness; however, thicknesses of beds being mined are approximately 18 to 36 inches. The principal coal beds presently mined are the Crowberg, Mineral, Tebo, and Weir-Pittsburg.

Six coal companies are in operation, and one field is under development.

Ellis Coal Company, Bronaugh, Vernon County
Hoppe Coal Company, Clinton, Henry County
Madole Brothers, Windsor, Henry County
Nichols Coal Company, Rich Hill, Vernon County

Peabody Coal Company, Power Mine, Montrose, Henry County and
Tebo Mine, Calhoun, Henry County
Pittsburgh & Midway Coal Mining Company, Barton County (under development).

Table 3. Estimated Cumulative Coal Production & Reserves: South Grand-Osage River Basin, Missouri

Cumulative Production	Reserves	
	Hinds (1912)	Searight (1966)
100 to 120 million tons	10.8 billion tons	5.2 billion tons

The largest estimated reserves within the Basin are in Bates (2.3 billion tons) Vernon (1.257 billion tons) and Henry (832 million tons). As can be seen from the above coal reserves, they are ample to meet future increased requirements.

Petroleum: Since the 1930's, the production of "high gravity-low viscosity" crude oil from the western edge of the Basin (Cass, Bates, and Vernon Counties) has been fairly continuous. Five small pools are presently active; one each in northwestern Cass and southwestern Jackson and three in northwestern Vernon. Production is from shallow stripper wells and generally averages less than 10 barrels per day per well. Recent figures are not available for publication. The potential pool sizes and reserves in the area will be small. Urbanization and increasing land values will limit if not exclude future exploration and development in the Jackson-Cass county field. Leasing of large blocks of land and drilling will be limited in densely populated areas. It is doubtful that large production wells will be discovered and the importance of "high gravity-low viscosity" oil to the Basin economy will remain minor.

An important petroleum potential in the Basin would be recovery of the "low gravity-high viscosity" or "heavy" oil present in the asphaltic sandstones underlying Barton, Bates, and Vernon Counties. A number of pilot tests have been attempted, but to date none have been economic. Estimates of the reserves of "heavy" oil have been as high as 30 billion barrels. Should an economic recovery technique be developed, this area of Missouri and adjoining Kansas would become a major center of oil production. The "heavy" oil is present in the lower Cherokee sandstones--the Warner and Bluejacket. The units crop out or are near the surface in the Area IV portion of Barton, Vernon, and southern Bates County. Thickness of the "heavy" oil saturated zones ranges upwards to 30 feet. In the subsurface "heavy" oil is encountered at depths upwards to 700 feet in the Cass County area.

Natural Gas: Since the mid-1940's there has been little to no natural gas production from the western portion of the Basin. Early production was principally in Cass County from shallow wells in the Pennsylvanian sandstones. Potential future production would be essentially restricted to Areas I, II, III, and IV; however, it is unlikely that natural gas will be of any future importance to the Basin's economy.

Non-Metallics

Non-metallic minerals extracted within the Basin are: stone, asphaltic sandstone, sand and gravel, shale and barite. Stone is by far the most important in both tonnage and value. In 1967, non-metallics represented approximately 45 percent of the total mineral value; of this, about 95 percent was stone.

Crushed stone, sand, gravel, and asphaltic sandstone are directly related to the economy and construction activity (roads, housing, and industrial) of the area. In addition to supplying construction needs, limestone and dolomite are quarried for agricultural liming. These commodities are high tonnage-low cost units with rather restricted haulage distances. The location of stone quarries, and sand and gravel pits reflect not only availability but local demand. The production of both construction aggregates and aglime have shown annual tonnage increases, and this trend is expected to continue. Since the production of crushed stone, sand, and gravel are related to demand, it is of interest to note that population projections to the year 1990 indicate a loss of from 1,000 to 3,000 persons per county for 13 of the 17 counties comprising the major portion of the Basin. Although the overall Basin area will show a population increase over the projected period (1967 to 1990), approximately 96 percent of this increase will be in two counties: one, Greene County, is only partly in the Basin; and the other, Cass County, is directly related to the Kansas City metropolitan area which lies outside the Basin. Camden and Vernon Counties are expected to show an increase of less than 7,000 persons. The projected loss of nearly 30,000 in the population of the remaining 13 counties is not expected to curtail the demand for construction aggregate. New highway and building construction in the areas of the major lakes within the Basin (Lake of the Ozarks, Pomme de Terre, Stockton, and Kaysinger Bluff), improvement and maintenance of existing roads, and the general trend toward higher per capita consumption of aggregates will require increases in production and additional quarry sites.

Stone: The major rock types within the Basin suitable for stone production are limestone, dolomite, and sandstone. Products are limestone and dolomite aggregates, agricultural limestone and dolomite, unfinished marble blocks and dimension limestone and sandstone. In 1967, stone production amounted to slightly over 2 million tons valued at $3.9 million. More than 99 percent of the production was crushed limestone and dolomite for construction aggregates and aglime. Quarries are known to be active in all but Dallas County. Those counties with a production in excess of 100,000 tons were: Bates, Cass, Dade, Greene, and Henry. The largest tonnages were reported from Greene and Henry Counties.

The availability and types of stone within the Basin vary with the seven areas outlined on Map 4. The geologic sequence, names, lithologies, and thicknesses of units are given in the section titled Geology.

Limestone and dolomite: These rock types are the principal rock types utilized and available for future exploitation in the Basin. Major uses are as aggregate in portland cement concrete and asphaltic paving, ready-mix concrete, base stone and road metal, and for agricultural liming. High calcium limestone is quarried in Greene County (Springfield) for the manufacture of

quick- and hydrated-lime; however, both plant and quarry are located outside the Basin proper.

The general limestone and dolomite resources by area are:

Areas I & III - thin units, 10 to 30 feet thick, separated by clays, shales and sandstones. Five principal units available--Argentine, Winterset, Bethany Falls, Myrick Station, and Higginsville. Of the four, only two--Bethany Falls (Area I) and Higginsville (Area III) generally pass specifications for portland cement concrete aggregate.

Areas II & IV - with the exception of inliers and outliers of limestone units of Areas I, III, and V, Areas II & IV are essentially devoid of limestone resources.

Area V - predominantly thick limestones, 50 to 100 feet. Several (Warsaw, Keokuk, and Burlington) are satisfactory for portland cement concrete aggregate and have chemical qualities suitable for the manufacture of lime and cement. The area is a source of high-calcium aglime and furnishes aggregate for portland cement concrete paving to Areas IV, VI, and VII.

Area VI - thick sequence, 200 to 300 feet, of dolomite (Cotter-Jefferson City). Highest construction aggregate use is asphaltic concrete. Source of high magnesia aglime.

Area VII - predominantly cherty dolomite (Gasconade), generally suitable for low type aggregate use. Upper 50 feet of Gasconade dolomite and inliers of Eminence dolomite sufficiently low in chert to be suitable for asphaltic concrete and high magnesia aglime.

The limestone resources of Area V and dolomite resources of Areas VI and VII are sufficient to supply future requirements of the Basin and adjoining areas. In Area I, the thinness of individual units resulting in larger acreage required per quarry plus urbanization combine to limit the available near surface resources with the exception of urbanization, Area III faces the same problem.

Marble: Two limestone units (Burlington & Warsaw) are suitable for polished marble. Large blocks are quarried in northwestern Greene County and shipped to Carthage, Jasper County, for cutting and polishing. Sufficient reserves appear to be present in Area V for all future needs.

Sandstone: A small amount of dimension sandstone is quarried in Area VII. Two units (Roubidoux & Gunter) in the Area are the principal resource and are more than sufficient to meet any future demands. In the past, minor amounts of sandstone in Area IV have also been used as dimension stone.

Asphaltic Sandstone: Two Cherokee sandstones (Warner and Bluejacket), which contain a high percentage of low gravity-high viscosity oil (described under Petroleum), have been quarried for a number of years and used in paving. After quarrying, the sandstone is crushed and heated and additional asphalt is added. Two companies, one each in Barton and Vernon Counties, are presently in operation. The asphaltic sandstone crops out in Area IV, Barton and Vernon Counties; attains a maximum thickness of about 30 feet; and reserves are unlimited.

Sand and Gravel: Production of sand and gravel is mainly from the eastern one-half of the Basin (Areas VI and VII). The annual tonnages have been declining in recent years. In 1960, 250,000 tons were reported from 12 counties; in 1967 only 82,000 tons were reported from three counties. The largest tonnages have been reported from Miller County. Uses of sand and gravel are ready-mix concrete aggregate, bituminous surfacing and road metal.

The major reserves of sand and gravel are the alluvial flood plain and in-channel deposits of the Osage River and its major tributaries. These reserves are principally in Areas VI and VII. Gravel deposits are present in Area V, but there is a deficiency in sand. In Areas I, II, III, and IV streams contain fine sand, silt and clay, and commercial sand and gravel for construction uses are essentially absent. An exception are high terrace deposits along the Osage and Marmaton Rivers in Bates, Henry, and Vernon Counties. These deposits have been worked; however, they are small and of limited extent. In Areas I thru V crushed stone has replaced gravel for most construction uses and sand is brought in from Areas VI and VII and from outside the Basin. Only Areas VI and VII can be said to have unlimited reserves of sand and gravel for future needs. Projected production to 1990 is expected to increase to 300,000 to 400,000 tons per year.

Clay and Shale: The last production of shale in the Basin was by the Acme Brick Company at Harrisonville, Cass County (Area II). The plant was closed in late 1969. The Pennsylvanian Pleasanton shale was utilized in the manufacture of face brick. Shale resources are present throughout Areas II and IV and in parts of I and III. In addition to brick manufacturing, some of the shales and clays have been found suitable for the production of a lightweight aggregate. Future shale and clay production will depend on the introduction of a lightweight aggregate or brick and tile industry in the resource area.

Barite: The Central Barite District, lying in the northeast portion of the Basin (Areas VI and VII), has been a minor source of chemical grade barite. Cumulative reported production from the Basin has been slightly over 100,000 tons. The bulk of this production was during the period 1910 thru 1941. Nearly 50 percent of the total was from Morgan County. Three mines are known to be active; however, reported production has been sporadic. Deposits are erratic in distribution, size, and shape. The majority are small. The deposits are filled sinks known as "circles." The barite, generally associated with lead and zinc, is present as fracture fillings of the collapse breccia or rubble. The future of the area as a major source of barite depends largely on a rise in ore prices and demand. The nature and distribution of the barite deposits are not conducive to large scale exploration and development at the present market price.

Refractory Clay: A small portion of the Southern Fire Clay District extends into the eastern edge of the Basin (southwestern Maries County); several outliers are present along the northeastern edge (Miller and Morgan Counties). Fire clay is present as fillings in sink holes. The size and distribution of the deposits are erratic. The clay is predominantly flint (30 to 40 percent Al_2O_3). Mining has been sporadic and there has been very little activity in the areas within the Basin. Reserves are limited, and it is doubtful that large tonnages will be found.

Metallic Minerals

Small near surface deposits of lead, zinc and iron are present in the Basin. Production was of minor importance in the past. There has been little to no exploitation of the deposits in recent years, and development is unlikely. The future for metallic production from the Basin would lie in the discovery and development of deeply buried deposits.

Lead-Zinc: Essentially all the lead-zinc mining took place in the area prior to 1910. Reported cumulative production for this period amounted to approximately 10,000 tons of lead and 1,500 tons of zinc. The latest year of known production was 1944 (Camden County). About one-third of the known production was from Morgan County. Other counties are Benton, Camden, Hickory, and Miller.

Ore is present as veins in the bedrock and as fracture fillings in the brecciated rock in filled-sinks or "circles." Distribution, grade, and size are erratic and do not lend to large scale exploration and mining. Minor amounts of lead and zinc have been recovered as a co-product of barite mining. Future development of the near-surface lead-zinc deposits are considered unlikely. An unknown potential lies in the possibility of deep deposits. Deep drilling to date has not indicated mineralization; however, the area has not been thoroughly explored.

Iron: The Osage River and Springfield Iron Districts lie wholly within the Basin. Production has been very minor and sporadic. Last reported production was in 1958 from the Springfield District and 1957 from the Osage River District. Deposits are shallow and erratic in size, distribution, and grade. The ore is predominantly "brown iron ore or limonite." These deposits have been of little importance in the past, and the future appears even less promising.

A number of minor magnetic anomalies are present within the Basin. None have been reportedly drilled to date. Several major anomalies in areas adjacent to the Basin have been drilled and at one disseminated magnetite has been reported in a Precambrian basic rock. It is likely that additional drilling will be done in the areas of the larger anomalies.

SUMMARY

The mineral potential of the South Grand-Osage River Basin lies principally in the coal, stone, sand and gravel deposits. production of each is anticipated to show annual increases throughout the remainder of this century.

The bulk of the production will be consumed within the region. The "heavy" oil or asphaltic sandstones in Area IV could become an important source of crude petroleum should an economic recovery technique be developed. Known metallic deposits hold little potential. Deep drilling of the known anomalies could result in discovery of buried deposits.

With the possible exception of Areas I thru IV, the Basin is self-sustaining in construction aggregates, the main industrial mineral required for future growth.

ENGINEERING GEOLOGY

AREA I

Bedrock underlying the area is composed chiefly of interlayered shales and prominent limestones. Soil cover over the limestone-shale sequence averages 10 to 12 feet but typically is thinner on limestone outcrops. The soil formed on the limestone is a moderately pervious clay that may contain chert fragments.

Generally, the area is suitable for most types of construction. However, expansive clay subsoils overlying shale layers will adversely affect some construction. Limestone bedrock will be a construction problem on slopes adjoining the uplands where soil cover is shallow.

The steeper slopes adjoining the major valleys in Area I are underlain by thick limestones. Soil cover varies from 0 to 10 feet. Two limestone members, the Bethany Falls and the Winterset, are major bluff formers. They are generally restricted to steeper slopes and are less apt to affect general urban development and construction. The thick limestones, underlain by shales, are subject to sliding and block movement on the steeper slopes. Cut design should take into account undercutting of limestone which contributes to the block movement.

The alluvium in small tributaries of Area I generally makes excellent sites for water impoundment structures. The alluvium material consists of silty clays, fine sand, and locally gumbo clay. Waste disposal sites will be most seriously affected where limestone outcrops are extensive.

Detailed engineering studies should be made for projects in Area I. Slope stability, thickness, and type of soil and bedrock vary greatly with minor changes in elevation due to the cyclic sequence of moderately thin shales and limestones in this area.

AREA II

Portions of Area II are overlain by thick deposits of sandy and clayey sand soils derived from the weathering of the sandstone and shale bedrock. The soils combine to form a moderately permeable overburden. The soil cover in upland areas underlain by the Pleasanton varies from 10 to 25 feet in thickness. The steeper slopes in the area may have a relatively thin sandy soil cover with thick deposits of sand and sandy clay in the river bottoms.

The silty shales and sandstones and occasional limestones are firm and should not present unusual problems in construction. Some of the shales are expansive and will require special treatment to eliminate swelling. Water impoundment and waste disposal sites are most affected where thin, sandy soil overlies sandstone. Aside from the foregoing, there will be few problems in this area.

AREA III

The silty shales and thin sandstones are firm and relatively watertight. Locally, thin soil cover over sandstone can contribute to water loss in a lake or sewage lagoon. Serious problems in the outcrop belt of the Higginsville limestone should be expected. Some of the silty shales are expansive and require special treatment for construction. Soil cover in the upland area underlain by the Marmaton varies from 10 to 25 feet in thickness, depending upon the degree of slope. In the valleys, where sufficient quantities of silt, silty clay, and sandy material overlie the thick limestone units, water impoundment structures can be successful.

AREA IV

The soil cover in Area IV ranges up to 10 or more feet in thickness. The combination of weathered sandstone, clay, limestone, and shale produces a relatively plastic and watertight soil. The topography has a relatively low relief which is partially related to the soft shale beds. Some of the shale and clayey soils are of the expansive type and special consideration must be given when these soils are encountered. Due to the thick shales present, with plastic soils on the surface, Area IV is a relatively problem-free area for water impoundments except where sandstones with thin soil cover are present. This also assists in the location of waste disposal sites. However, the firm sandstone beds are more apt to be exposed than shale due to their resistance to erosion and their permeability can be detrimental to lakes and sewage lagoons.

AREA V

The red clay soil of Area V is moderately permeable, has a low natural density, and is difficult to compact. Underlying the soil, in Area V is a highly soluble limestone that is subject to sinkhole development and solution enlarged crevices.

The residual clay soils and overburden will vary in Area V from 0 feet to as much as 50 or more feet. The bedrock surface is very uneven and a pinnacling effect can be seen in many outcrop areas. This is due to solution of the bedrock along the joints or fractures.

The bedrock and overlying soils are generally building construction projects. However, due to the irregularity of the bedrock surface, the permeability of the soil and the presence of numerous cavities in the bedrock, substantial site investigations must be made prior to construction. This is particularly true for lake sites and waste disposal locations. Also, discharge of waste effluent into a solution affected valley can cause water pollution as readily as if the waste treatment were leaking directly into the ground water.

AREA VI

The soil thickness varies considerably in Area VI. The high ridges and steeper bluffs may have no soil or a thin glade soil. The gentle slopes and valleys may have from 10 to 50 feet of a tan, silty clay, and chert gravel. Highly permeable, sandy, silty clay and chert gravel alluvium is prevalent in the deeply eroded valley bottoms. Soils, depending upon whether they are located on the ridgetops, valley walls or valley bottom, can vary from a plastic clay to a non-plastic sandy, silty clay. Where the flaggy dolomite is not covered by a thick residual mantle, permeability is high. The permeable flaggy dolomite can transmit large quantities of water to the subsurface which contributes to karstification of the underlying formations.

Except where karstification has taken place in the underlying formations, no unusual construction problems could be expected. Detailed geology and soils engineering is needed in Area VI due to the uneven thickness of soil material in local areas. This is particularly true before final locations are selected for lake sites and waste disposal facilities. Some rather large outliers of Mississippian rock (Area V) are located in the central portion of Area VI.

AREA VII

Area VII differs from Area VI in that the residual cover material in Area VII is generally thick, permeable, and very stony. Residual clays and chert gravel derived from the Roubidoux Formation allow rapid percolation of surface water into the underlying cavernous Gasconade Dolomite.

Soils varying from 0 to 20 feet or more in thickness are common on both the Roubidoux and Gasconade Formations. Both formations produce residual soils that are characterized by a high chert content.

Water loss in some of the major streams in Area VII can be attributed to the permeability of the soils and the jointed nature of the bedrock. Many of the lesser tributary streams are dry during major portions of the year.

The construction problems prevalent in Area VII center about the difficulty of building lakes and waste or sewage lagoons that hold water. If dense housing areas rely on septic tanks, pollution of springs and shallow ground water can occur. Caves and sinkholes contribute to foundation failures in highways and water retention structures.

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